ON THE COVER

CURBING weeds, brush, and unwanted grasses on railroad rights-of-way is a big assignment. Formerly grubbed, this rank growth is now killed with chemicals, which are applied from moving trains that are generally similar but vary in details. Some lines develop and operate their own spraying equipment; others turn the job over to specialists such as Spray Services, Inc., which designed the train shown in operation on the front cover.

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IN THIS ISSUE

ATMOSPHERIC pressure, normally 14.7 psi., forms the dividing line between two branches of the pneumatic kingdom. Above the line is the province of compressed air; below it the realm of the so-called vacuum. Most of us can readily understand what goes on above the line; but, even to many engineers, the things that transpire in the subatmospheric zone are cloaked in considerable mystery. Our leading article will perhaps clarify the subject a bit. There is, of course, no such thing as a perfect vacuum, and the term vacuum is at best indefinite and unsatisfactory. It does, however, convey an idea to the layman that would be hard to transmit by the more accurate reference, namely, absolute pressure. One interesting bit of information that is not in the article has to do with the density of molecules in the normal atmosphere. They are so numerous, it is said, that in the best vacuum obtainable with existing equipment there are still more molecules of air per cubic centimeter than there are people on earth.

•

IF YOU have a garden, you know what weed trouble is. So do the railroads, but they are finding ways to combat these pests with a minimum expenditure of muscular energy. Their chief problem is to devise equipment that will apply chemicals with speed and economy. Three different solutions are presented in the article that starts on page 150.

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MOST gold miners are poor people in these inflated times, but base-metal miners are doing right well. Canada's New Calumet Mines, never before a profit maker, was resurrected during World War II to produce badly needed lead and zinc. It was supposed to have only a temporary life, but it is still going strong. Page 155.

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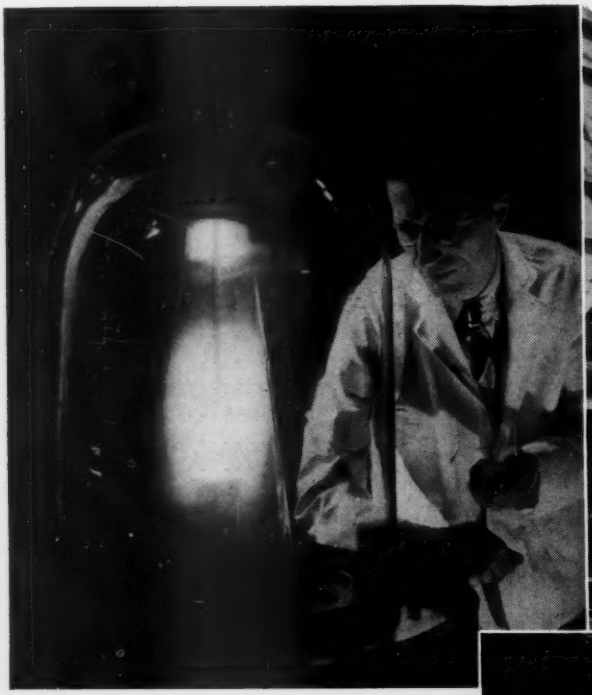
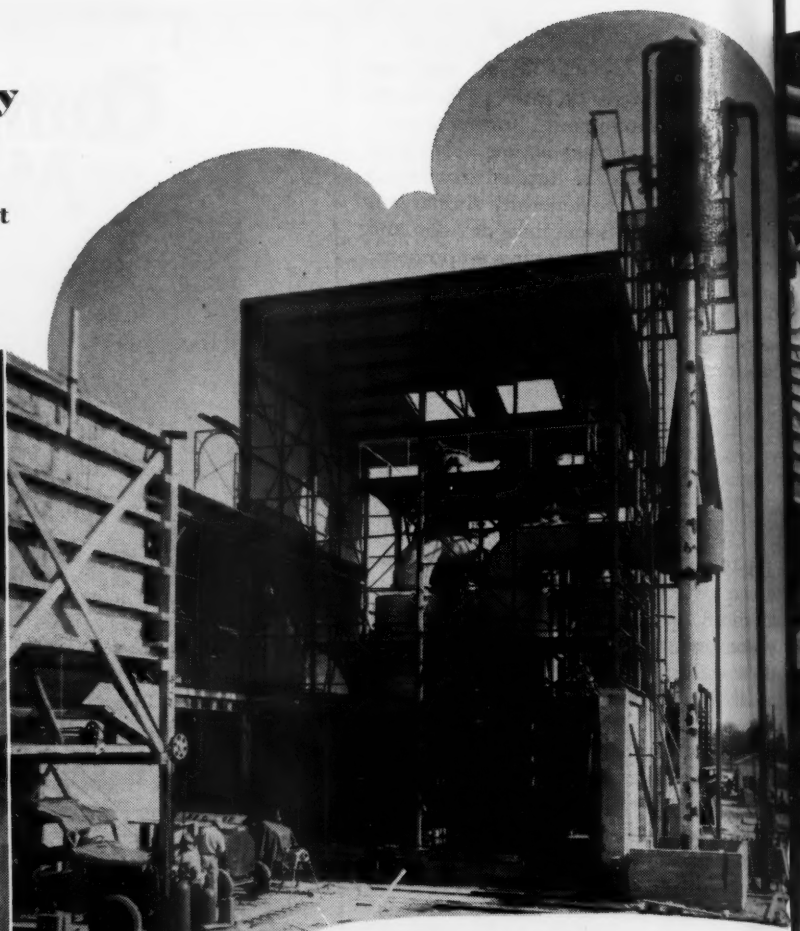
VACUUM —

the Magic Hat of Industry

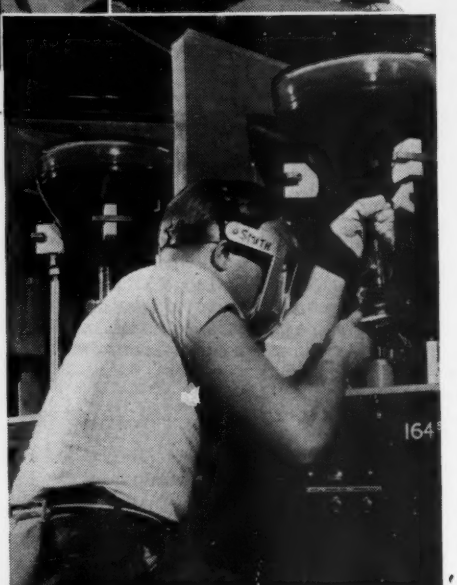
Empty Space Is One of Industry's Most Important Working Tools



CATHODIC VACUUM ETCHING
Physicist Don M. McCutcheon of the Ford Motor Company is shown above with the apparatus developed by Ford technicians for preparing metal specimens for examination of their microstructure. The specimen is placed under the bell in an extremely high vacuum containing argon gas, and a charge of 12,000 volts of electricity is then introduced. This creates argon ions that bombard the metal's surface and knock off minute particles. This brings out the true structure with greater detail and clarity than can be achieved by etching with acid.



CITRUS-FRUIT CONCENTRATOR
By evaporating and removing most of the water content at low temperatures, delicate liquids such as citrus-fruit juices can be concentrated without affecting their flavor and without destroying their valuable vitamins. Illustrated above is a double-effect, high-vacuum, low-temperature downflow evaporator manufactured by the Buflovak Equipment Division of Blaw-Knox Company. It is being set up in a plant that turns out frozen orange juice. The vacuum is produced by means of steam-jet ejectors.



DISTILLATION PRODUCTS INDUSTRIES

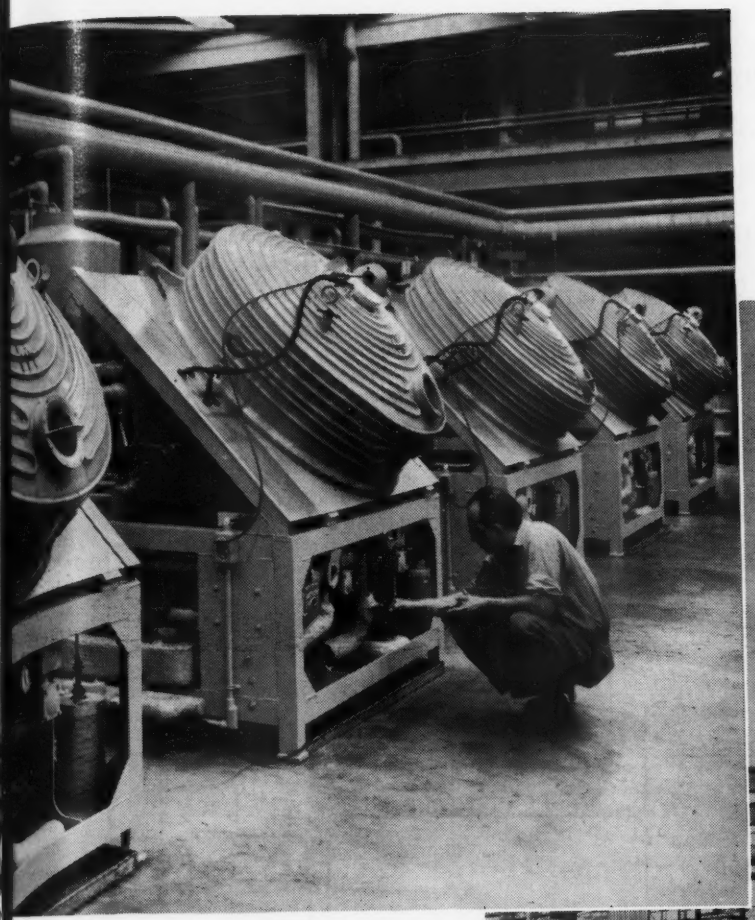
TELEVISION TUBES
Electric-light bulbs and various types of electronic tubes are evacuated. In the case of the latter, the thinning out of the molecules of air facilitates the travel of the electrons. The picture shows an operator sealing a cathode-ray television tube after the withdrawal of most of its contained air.

HAVE you ever seen a magician reach into a supposedly empty hat and pull out a live rabbit, a bird, or a string of gaily colored handkerchiefs? If you have, you probably enjoyed the show but scoffed at the idea of getting something from nothing. Yet every day industry, just like the magician, reaches into empty space and brings forth an amazing variety of things to make your life easier and more enjoyable, and neither you nor the rest of the audience scoffs a bit.

Vacuum is industry's magic hat. It makes possible the radio and television tubes that bring entertainment into your home. It turns out the frozen orange juice that you find in your grocery. It gives you penicillin, vitamins, and blood plasma; has a hand in the manufacture of the records you buy for your phonograph; and helps to bring fresh, delicately flavored vegetables and fruits from farm and orchard to your table.

Many things that cannot be done under ordinary air pressure are feasible under vacuum. For example, water will boil even when it's cold, and matter that is frozen solid can be dried. Electrons, atoms, and molecules can be made to move in controlled paths instead of in random directions. Glass, plastics, cloth, and other materials can be coated with metal, and metals or paper can be impregnated with oil, wax, or plastics. Gas bubbles can be prevented from forming in molten metal, and new metals can be produced. Complex organic substances can be torn apart and their different molecules collected separately.

Like compressed air, vacuum has been known for centuries. But it was not until about 1654, when Otto von Guericke of Magdeburg, Germany, made his now

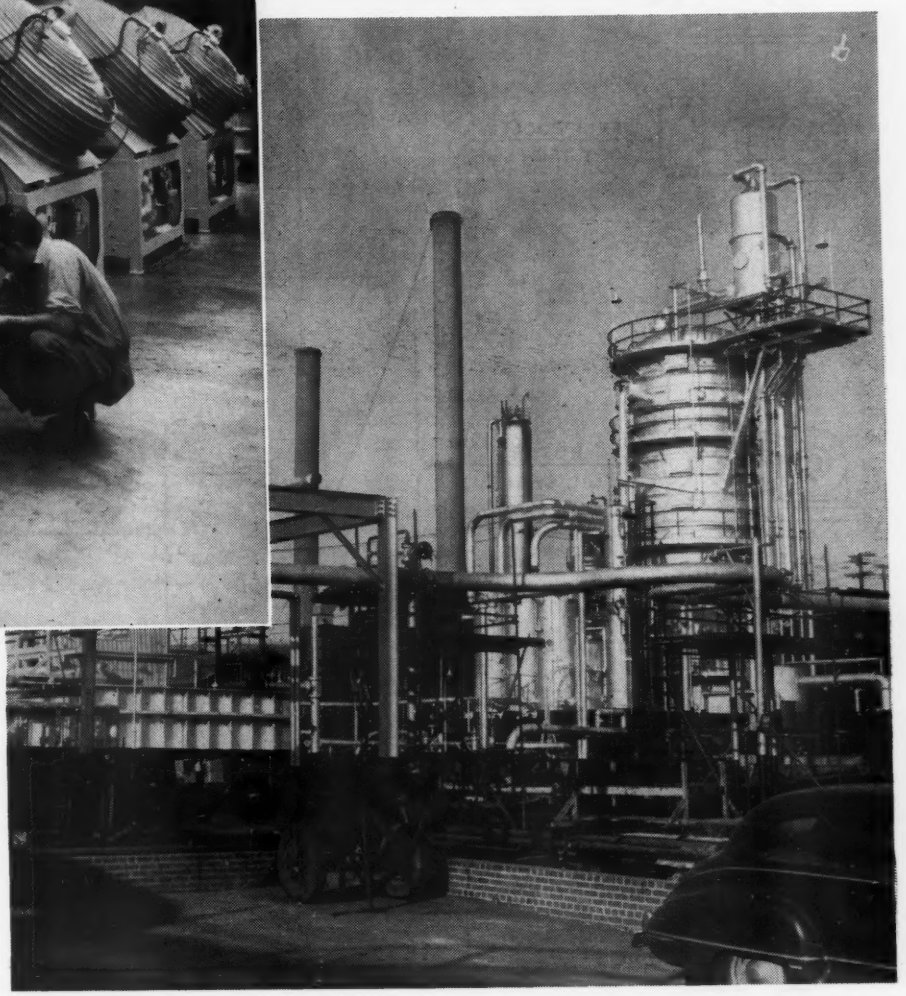


MOLECULAR-DISTILLATION UNITS

Because the molecules of a complex liquid have different weights, they can be separated under vacuum distillation. The lighter ones are the first to volatilize and, by reducing the pressure in steps, the others can be extracted in turn. Pictured above is a bank of 36-inch molecular stills designed for service in the production of vitamins. The photograph was taken in the plant of the manufacturer, Distillation Products Industries, a division of Eastman Kodak Company.

PETROLEUM-DISTILLATION UNIT

In the vacuum still shown below, Union Oil Company of California produces Triton motor oil at its Oleum, Calif., refinery. A mixture of clay and petroleum-residue stock is fed, at the rate of 2700 barrels a day, to the 13½-foot-diameter column containing fifteen fractionating trays. The feed enters the still at the third tray from the bottom, and steam at a temperature of 665°F. is introduced at the bottom. Two steam-jet ejectors that discharge into a barometric condenser reduce the absolute pressure in the top of the tower to 25 millimeters of mercury. The unit was built by Filtrol Corporation, of Los Angeles, Calif.



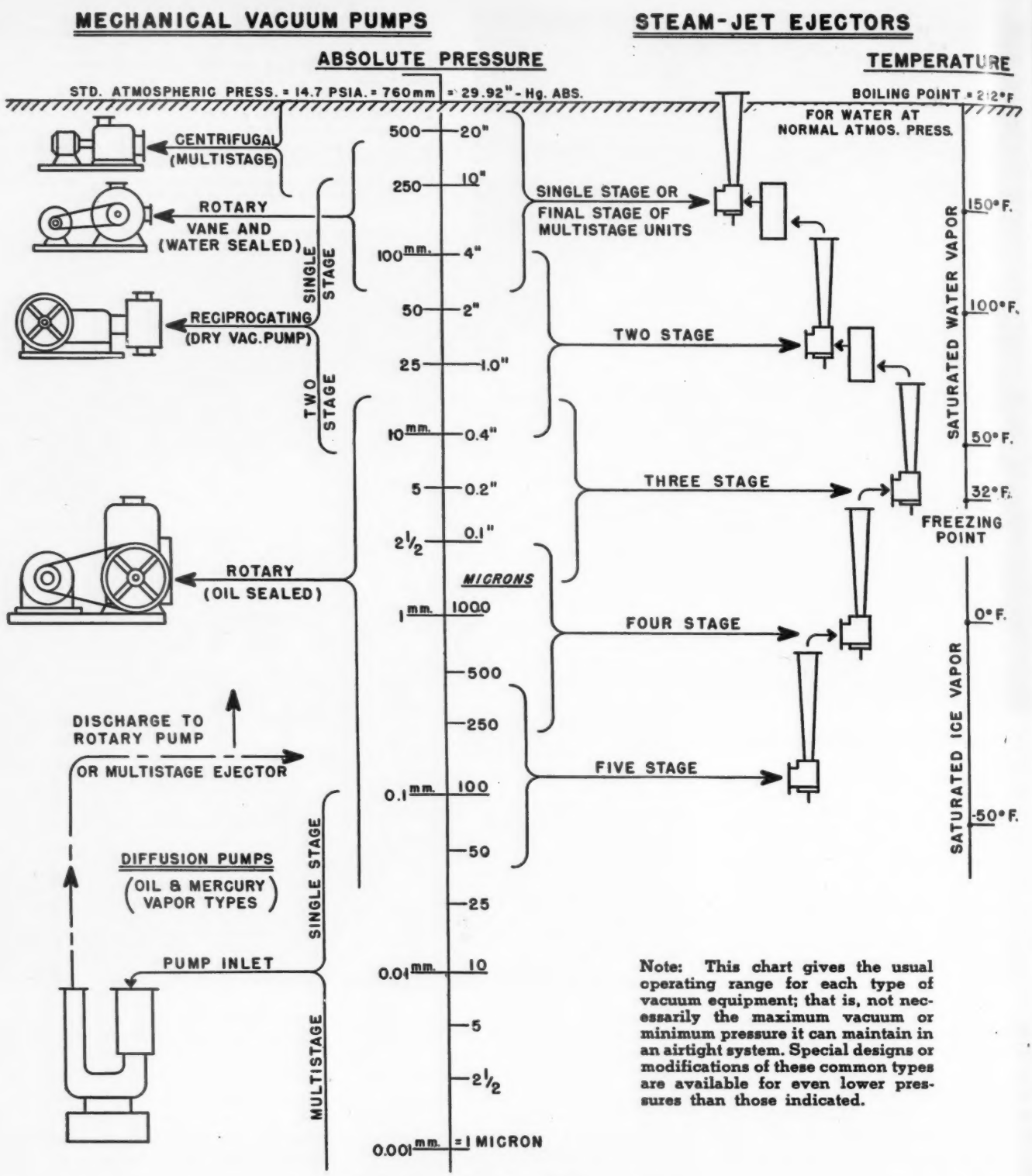
classic experiment, that scientists began seriously to study and apply vacuum. Von Guericke took two copper hemispheres about 22 inches in diameter and placed them together loosely with an oil-soaked leather ring between their edges to form an airtight joint. After exhausting most of the contained air by means of a crude vacuum pump he had invented, he hitched two 8-horse teams to the hemispheres and tried to pull them apart, but in vain. His failure to separate them dramatically demonstrated the power of vacuum but gave no hint as to its future industrial usefulness.

Not long after von Guericke's experiment, scientists constructed what probably was the world's first high-altitude test chamber. Naturally, they had no interest in the effects of rarified atmospheres on men in flight. However, they did observe the curious effects they had on animals, and probably concluded that it was harmful to subject humans to such atmospheres. These studies were purely academic, and it was years before vacuum was put to any significant use.

One of the earliest practical applications was made in 1803 by Richard Trevithick, a pioneer builder of steam locomotives. He utilized the exhaust steam from the engine to induce a draft in the stack by ejector action, thus promoting better combustion in the firebox. This idea is still incorporated in modern locomotives, and virtually in its original form. James Watt used vacuum rather than steam to supply the driving force for his steam engine, and the turbines of all up-to-date steam-power generating equipment exhaust into a vacuum, thus practically doubling the power produced by each pound of steam.

Today, vacuum is one of industry's most important tools. It figures in the making of a large number of products ranging from atomic bombs and jet engines to hair barrettes and costume jewelry. Yet, to most people, vacuum remains something of a mystery—a mystery that has been deepened through confusion resulting from the multiplicity of terms applied to it. Vacuum is created by removing air or other gas from a space. As the gas is withdrawn, the pressure within the space becomes less than that in the surrounding atmosphere. The degree of vacuum induced is a measure of the extent to which the gas has been removed: if it amounts to only a small percentage a low vacuum results, if most of it is extracted a high vacuum is obtained. If all the gas could be removed, the space would be entirely empty and the pressure in it absolutely zero—a perfect vacuum.

Since von Guericke's time, vacuum has meant a pressure lower than atmospheric pressure. The latter was the base



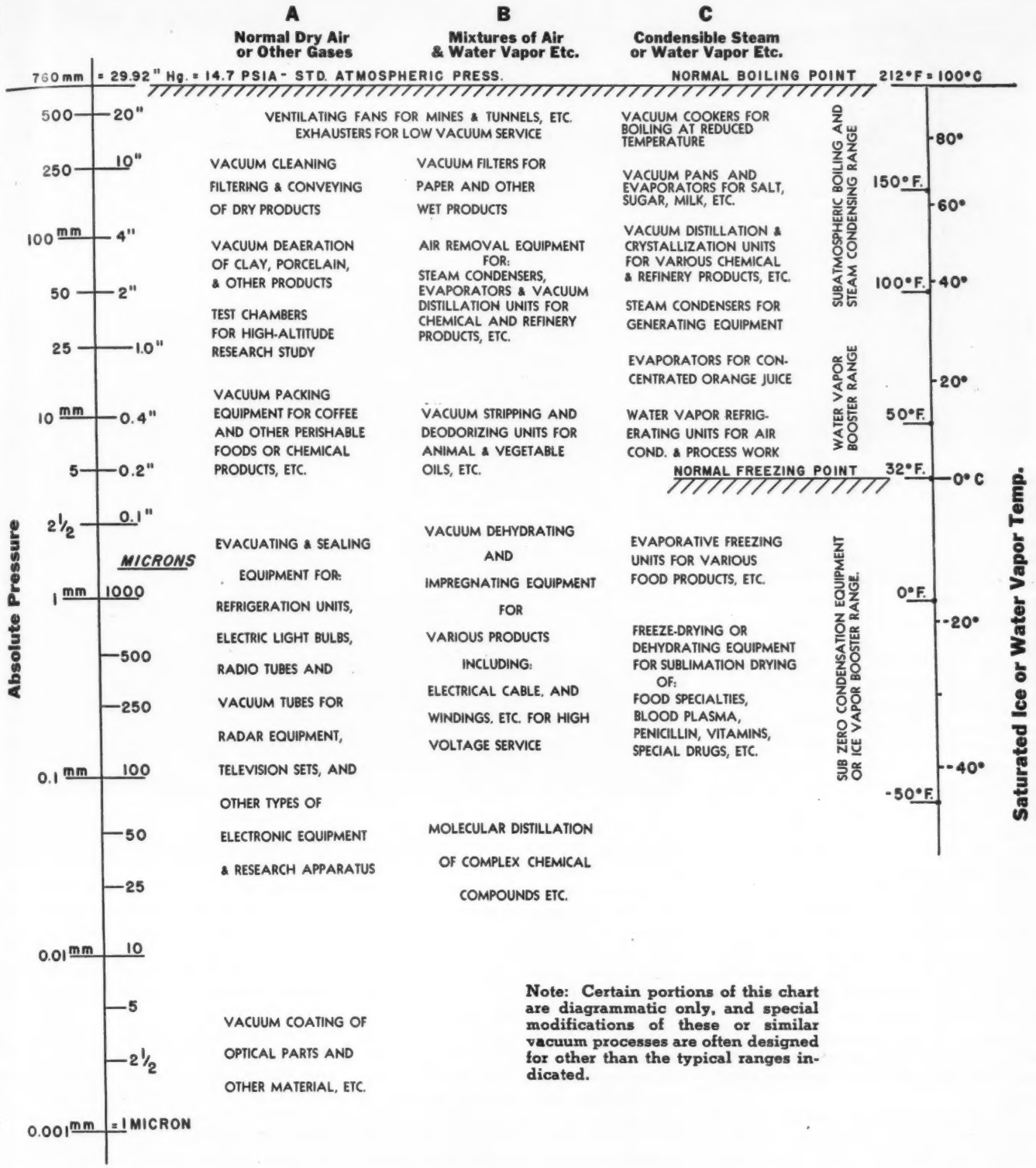
Note: This chart gives the usual operating range for each type of vacuum equipment; that is, not necessarily the maximum vacuum or minimum pressure it can maintain in an airtight system. Special designs or modifications of these common types are available for even lower pressures than those indicated.

WHERE VACUUM EQUIPMENT APPLIES

The common types of vacuum-producing equipment used in commercial processes are indicated on this chart, together with the approximate operating range of each one. The central logarithmic scale shows absolute pressures in terms of both millimeters and inches of mercury. The right-hand scale gives the temperatures at which water or ice vaporizes at the corresponding pressures. Combinations of equipment are necessary to obtain extremely low pressures.

or reference line, with the arithmetical difference between it and subatmospheric pressure representing the amount of vacuum. On this basis, vacuum was akin to gauge pressure of compressed air, as both referred to the atmospheric pressure that existed at the time and place of observation. However, this system resulted in no little confusion, since atmospheric pressure varies with different localities and elevations and also changes from morning to night. It has proved to be a poor reference line. True, we have the "29.92-inch barometer," "standard atmosphere," and "referred vacuum," but these terms only slightly lessen and do not eliminate the uncertainty.

In recent years a successful attempt has been made to bring about a change in the reference line. The practice of speaking of subatmospheric pressure as a "vacuum"—a relative value—is giving way to the more foolproof method of calling it "absolute pressure"—an absolute value. Absolute pressure simply means the amount of pressure above a



Note: Certain portions of this chart are diagrammatic only, and special modifications of these or similar vacuum processes are often designed for other than the typical ranges indicated.

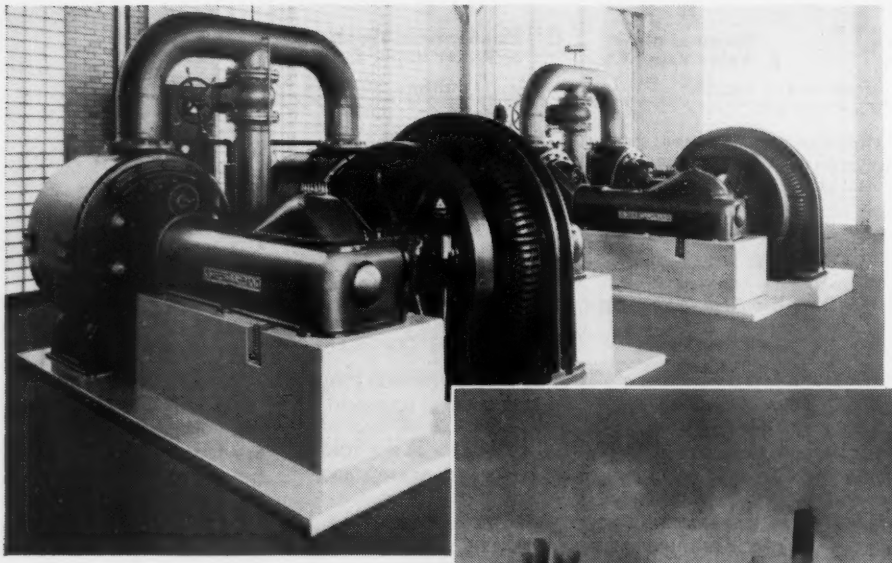
OPERATING RANGES OF VACUUM PROCESSES

Most of the principal industrial processes that necessitate the use of subatmospheric pressures are listed here, together with the typical pressure range for each one. The processes involve the evacuation or removal of various combinations of air, other gases, and water vapor, as shown under the three headings A, B, and C. The charts on this page and the preceding one were compiled by J. F. Plummer, Jr., of Ingersoll-Rand Company, Phillipsburg, N. J.

perfect vacuum. Thus, in the new terminology all pressures, whether above or below atmospheric, are based on a non-changing line—zero pressure at absolute vacuum—instead of the continually changing line of atmospheric pressure.

Atmospheric pressure will support a column of water some 400 inches high, or a column of mercury approximately 30 inches high. Pressures slightly below atmospheric are generally measured by means of a water manometer and expressed in "inches of water vacuum." Lower pressures are measured in "inches of mercury, absolute," or "pounds per square inch, absolute." For pressures much below 1 or 2 inches of mercury, absolute, it is more convenient to use the smaller units of the metric scale—"millimeters of mercury" or "microns of mercury," (a micron is 1/1000 millimeter).

Using the term "vacuum" instead of "absolute pressure" can result in considerable error unless the exact barometric pressure at the place of the reading is known. For instance, suppose the vacuum at an important point in a sys-



TWO TYPES OF VACUUM PRODUCERS

Most industrial vacuum processes fall within a pressure range that can be readily attained with a reciprocating vacuum pump or steam-jet ejectors, examples of which are shown here. Both are of Ingersoll-Rand manufacture. The synchronous motor-driven XRE vacuum pumps that are pictured at the left are installed in a glass factory. The other view shows fifteen large steam-jet ejectors that maintain a vacuum on "high-altitude" chambers used for testing aircraft equipment.

tem is registered as 29.0 inches of mercury. If the barometer reads 29.5 inches at the vacuum gauge, the absolute pressure is 0.5 inch of mercury. However, if the barometer indicates 30.0 inches, the absolute pressure is 1.0 inch of mercury or 200 percent of the first, yet the reading on the vacuum gauge is the same. Failure to take this into account may mean costly spoilage or loss of material undergoing processing.

Vacuum is generally created by means of vacuum pumps, which are essentially air compressors. But instead of drawing in air at atmospheric pressure and compressing it to higher pressures, vacuum pumps take air at subatmospheric pressure and raise it to atmospheric. The types of equipment used fall into three classes: mechanical pumps, steam-jet ejectors, and diffusion pumps. These are further classified according to the functions they perform. Ordinary pumps discharge directly into the atmosphere. However, by connecting the outlet of a primary-stage pump to the inlet of a secondary- or final-stage pump, it is possible to obtain lower pressures or higher vacuums than with the final-stage pump alone.

Mechanical vacuum pumps are of three main types: centrifugal, reciprocating, and rotary. The centrifugal, often called an exhauster, resembles a fan or blower. It exhausts air from a space through the compressing action of rapidly rotating blades, and can create only low vacuums. The reciprocating pump functions like a conventional mechanical air compressor, and a 2-stage unit can reduce the pressure in a vacuum chamber from atmospheric to approximately ½ inch of mercury, absolute. For lower pressures, rotary oil-sealed pumps are generally used. These have a sliding vane that describes a circular, sweeping motion inside a housing, the action being similar to that of a reciprocating pump. The internal parts are accurately machined and finished, and oil serves to seal the openings between the moving parts. Some pumps of this type can evacuate a space down to a pressure of less than 1 micron of mercury, absolute (0.001 millimeter).

Steam-jet ejectors depend on a high-velocity jet of steam to entrain and remove air from a vacuum chamber and to compress it to atmospheric pressure. Two-stage units of this kind can maintain pressures of less than ½ inch of mercury, absolute, in a vacuum chamber. If more stages are used—possibly three, four, or five—the pressure can be further reduced to around 50 microns or below.

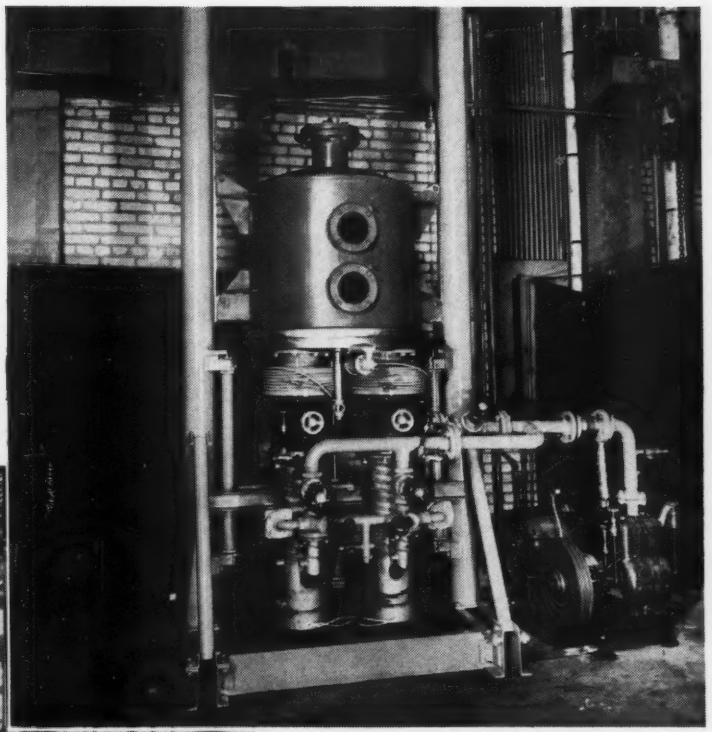
Diffusion pumps are required where extremely high vacuums must be reached. They trap molecules of air in mists of heated oil (or mercury) and drag them from the space being evacuated somewhat like a steam-jet ejector does. The oil is in a vat in the bottom of the primary pump and is heated electrically until it vaporizes. The vapor rises through a chimneylike sleeve to the intake of the pump, where it entrains molecules of air that have entered the pump from the compartment being exhausted. After conducting the air molecules to the discharge end of the pump and compressing them slightly, the oil molecules strike the water-cooled wall of the pump, where they condense and flow back to their starting point. The air molecules are then taken by some form of mechanical vacuum pump or steam-jet ejector, which pushes them out into the atmosphere. A modern multistage unit of this type can create pressures in the neighborhood of 0.005 micron of mercury.

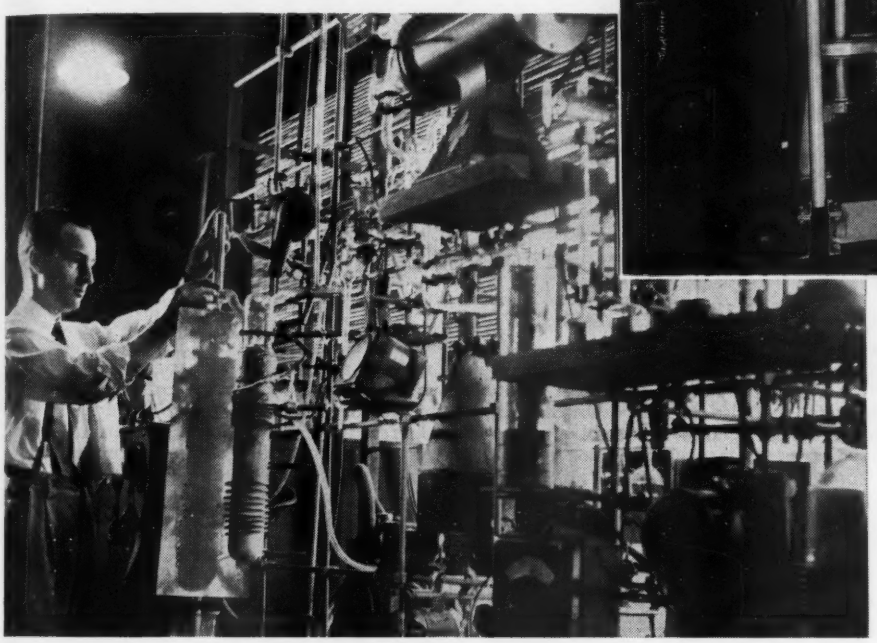
Although it is comparatively easy to force air into a chamber until the pressure amounts to thousands of pounds per square inch, it is something of a problem to produce and maintain a vacuum much below one micron. That's because the air molecules are relatively few and far apart at these low, absolute pressures. The pump, having no means of reaching out and grabbing the few left in a highly evacuated space, must wait for the occasional molecule to wander into it before it can remove it. Because of the slowness of the process and because no vacuum system can be made entirely leakproof, it becomes increasingly difficult to remove the last molecules of air and thus approach a perfect vacuum.

Although low, medium, and high vacuums have served industry for a long time and for many purposes, the application of ultrahigh vacuums was limited wellnigh entirely to scientific work until a

TWO METALLURGICAL AIDS

Metals may be fused at temperatures considerably below their normal melting points by heating them under a vacuum. Pictured at the right is a high-vacuum electric furnace designed for the Bureau of Ordnance of the U.S. Navy by the National Research Corporation, of Cambridge, Mass., under the technical direction of the Allied Physics Laboratory of Johns Hopkins University. It is used at Battelle Memorial Institute, Columbus, Ohio, for studying molybdenum and its alloys, with special attention to their use in heat engines and jet-propulsion equipment. Another application of vacuum in the metallurgical field is exemplified by the maze of tubes and gauges shown below. Called a vacuum fusion apparatus, it was developed by the Armour Research Foundation of the Illinois Institute of Technology to analyze the gases in a metal, which is helpful in predicting the latter's properties. Joseph McAndrew, associate metallurgist at the foundation, is pictured with the equipment.





comparatively few years ago, the reason being that equipment which could economically maintain such low pressures was practically nonexistent. Recent advancements in the techniques of creating and using ultrahigh vacuums, accelerated greatly by developments made during World War II, have taken them out of the laboratory and put them on a production-line basis.

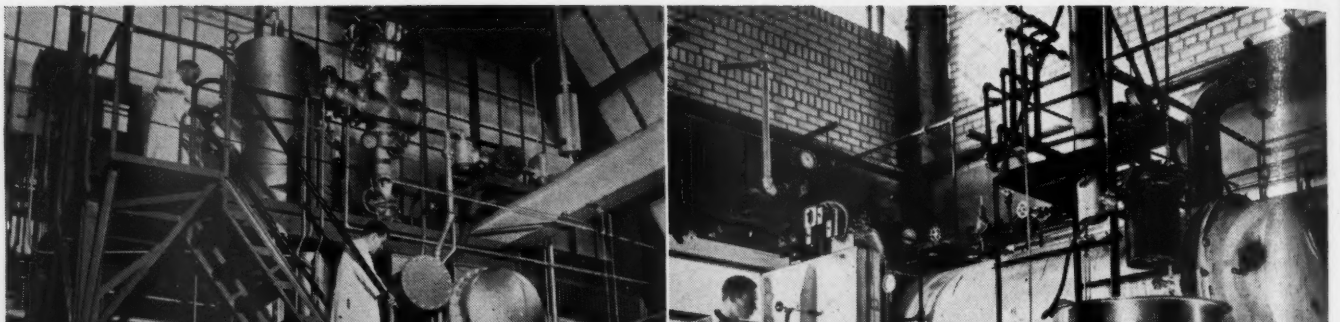
The initiation of the atomic-bomb project brought about a demand for vacuum systems of an unheard of size and capacity. High vacuums were needed to insure the electron and ion activity necessary in atom-sorting machines to separate Uranium 235 from the two other uranium isotopes. Similarly high vacuums are also required in the operation of cyclotrons, betatrons, and other atomic-research apparatus.

Chemical, food, and pharmaceutical industries find vacuum indispensable in many manufacturing or processing operations. Just as water boils at a lower temperature on a mountain than at sea level, so will other liquids boil or vaporize at lower temperatures when the surface pressure on them is reduced. Processes that involve evaporation, crystallization, distillation, and drying are therefore frequently performed under a vacuum. By its use, products which might be damaged or "cracked" at atmospheric boiling temperatures can be handled successfully. An example of this is milk, a heat-sensitive liquid that, for best results, must be evaporated at temperatures of about 125°F. or lower made possible by pressures of around 4 inches of mercury, absolute.

Evaporation plays an important part in the food industry. While it can be accomplished commercially by heating the foodstuffs, this procedure results in a loss of flavor and destruction of vitamins. But by processing them under a vacuum to reduce the pressure and thereby lower the evaporation temperatures they retain their nutritive value and their taste approaches that of fresh commodities. The wartime development of this method has promoted the growth of the postwar frozen orange-juice industry to the point where it is now concentrating juices of other citrus and noncitrus fruits such as grapefruit, lemons, grapes, apples, and tomatoes, and even fluids like coffee and milk. By another process now in use, fruits, vegetables, meats, fish, eggs, etc., are first preserved by quick-freezing and then subjected to evaporation under ultrahigh vacuums. The finished product is a powder rather than a concentrated liquid.

Newly ground coffee soon becomes stale in the presence of air because oxygen promotes rancidity. However, it will remain fresh for reasonably long periods if packed in containers from which most of the air has been exhausted. Modern plants are equipped with high-speed machines that automatically receive jars or cans filled with coffee, exhaust up to 98 or 99 percent of the air by means of heavy-duty vacuum pumps, tightly seal on caps or lids, and deliver the containers to a moving conveyor. Ears of corn, sweet potatoes, etc., are vacuum-packed in cans in a similar manner so as to preserve their flavor and goodness.

Blood plasma and penicillin owe their present state of commercial development largely to vacuum. The former must be prepared under strictly hygienic conditions and has to be dried rapidly to prevent the growth of bacteria and the deterioration of essential elements. The yellowish plasma that remains after the red corpuscles have been extracted is bottled and frozen, the open-topped bottles are placed on water-jacketed shelves in a vacuum chamber, and the pressure is reduced to about 0.5 millimeter of mercury. Warm water circulating through the jackets provides the heat needed to evaporate the moisture. Ultralow pressures have similarly brought about the low-cost production of penicillin. Globules of penicillin, taken from the mold cultures which produce it, are dropped



PHARMACEUTICALS AND COFFEE

Vacuum equipment plays an indispensable part in the manufacture of many medicinal products and drug extracts. The apparatus shown at the left is a stainless-steel evaporator designed to make a concentrate and also to condense and recover the solvents drawn off in volatile form. In processing the materials, temperatures are maintained within close limits by automatic controls in order to obtain the desired results. The equipment is used by a pharmaceutical concern in concentrating a heat-sensitive biological product. It was built by the Buflovak Equipment Division of Blaw-Knox Company. Pictured at the right is part of a pilot plant operated by the National Research Corporation for making instantly soluble coffee in powdered form by evaporating brewed coffee under a vacuum.

into bottles and frozen. In that state the containers are set on racks in a sealed vacuum chamber where dehydration is effected.

Molecular distillation is another industrial process that vacuum has made practicable. In a complex liquid, the different molecules do not all weigh the same. Therefore, when such a fluid is evaporated, the lighter ones are the first to fly off. At atmospheric pressure, the blanket of air above the surface of the liquid causes these volatile molecules to rebound—to return whence they came; but removing the air blanket by applying vacuum permits them to escape. By lowering the pressure on the liquid in a series of steps, the procedure can be controlled so as to distill and collect separately the diverse molecules of which it is composed. That is the way vitamins, particularly A and E, are extracted from fish-liver and other oils. The petroleum industry also makes extensive use of the process in separating oils, greases, waxes, and the like into several hundred different molecules which can be tested one by one for viscosity or stickiness at varying temperatures, for chemical instability, etc. In this manner the petroleum products can be literally "tailormade" for specific applications.

Using vacuum to chill water for industrial purposes is a practice that is steadily gaining favor. In what is known as a steam-jet cooler, the water to be chilled enters a heat-insulated flash chamber which is under vacuum maintained by a steam-operated booster ejector. Because of the greatly lowered pressure, some of the water flashes into vapor drawing heat from the remainder and thus lowering its temperature. The vapor is withdrawn continually from the chamber by high-velocity steam issuing from the nozzles of the booster ejector. In the process, it is sufficiently increased in pressure and temperature to be condensed by the normal supply of cooling water.

Because air molecules hamper the flow of electrons, the space in which an electronic device operates must be evacuated to an extremely high degree if it is to be effective. The electrons can then travel in straight lines without interference from the molecules. Some high-vacuum applications in radio and television tubes, X-ray tubes, and photoelectric cells require pressures below 0.001 micron of mercury.

Glass, plastics, paper, metal, cloth, and other materials are being coated with thin layers of aluminum, copper, gold, stainless steel, nickel, silver, zinc, etc., by means of vacuum. The objects are arranged in an airtight chamber in such a way that the surfaces to be treated all face a common point where the metallic substance is vaporized by passing an electric current through it. Because of the absence of air, the molecules produced travel in straight lines and are deposited on the exposed surfaces in an extremely uniform film that can be rigidly controlled both as to quality and thickness.

One of the principal uses of the process is the coating of camera lenses, prisms, and other optical glass with a film of magnesium fluoride or other metallic salts about four or five ten-millionths of an inch thick (one-quarter of a wave length of light). The coating causes the lenses to reflect less light and to let more light pass through, thus giving it greater light-transmitting efficiency.

Some types of sunglasses are being provided with built-in "sunshades" by the vacuum-coating method. This is done by applying to the upper half of each lens a film of stainless steel ranging from a relatively semitranslucent thickness at the top to an invisible coating at the center. The deposit reflects some of the sunlight shining down on the glasses and makes them especially valuable to flyers.

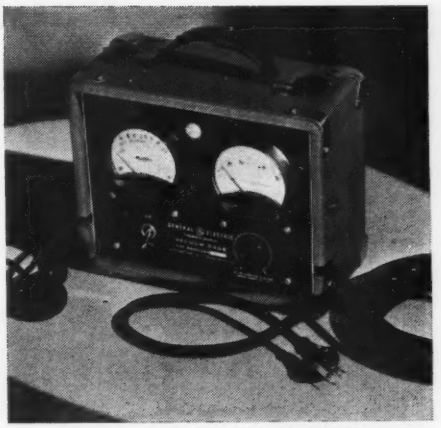
The process is likewise being used to advantage in the manufacture of metallized plastic parts for steering wheels and dash panels of automobiles; emblems and insignia for radios, refrigerators, and other household appliances; costume jewelry, etc. The faces of astronomical

and other optical mirrors are being covered with aluminum in a vacuum chamber to give them high reflectivity free from refraction or absorption attributable to the glass. Kraft paper is similarly receiving a thin layer of metallic zinc and is replacing bulky sandwiches of paper and metal foil in new, compact electrical condensers. Sequins for ladies' dresses are punched from acetate sheeting to which silver or aluminum is applied in an evacuated chamber. Incandescent bulbs for photographic and scientific work are sometimes partially coated with aluminum so they can also serve as spotlights, thus eliminating reflectors. Sealed-beam head lamps for automobiles are produced in the same manner.

Metallurgy is another field in which the use of vacuum is on the increase. Metal casting is a good example. Molten metals usually contain appreciable quantities of dissolved gases. When the hot metal is poured and begins to solidify, the gases are forced out, forming blowholes—pin-point pores—in the casting. However, if the surface pressure which holds the gases in the molten metal is reduced, the gases escape before the metal hardens. The result is a blowhole-free casting of high density, more than normal toughness and ductility, and of improved thermal and electrical conductivity—properties that are of extreme importance in the building of such things as jet engines for aircraft.

By the aid of vacuum, metals may be volatilized at temperatures as much as 1800°F. below their normal boiling point, permitting them to be separated from unwanted materials having a higher boiling point (a case in point is the reduction of magnesium metal from the mineral dolomite). Vacuum may also be used in refining calcium, antimony, beryllium, potassium, and magnesium, all of which are difficult to handle and process at atmospheric pressures. By removing most of the gases which could combine with the metal being treated, vacuum insures a product having a minimum of contaminants.

Cathodic vacuum etching is the latest method by which industry examines the structure of metals and alloys. A sample is placed in a vacuum containing argon, a rare gas, and high-voltage electricity is passed through the vacuum to ionize the argon. The ions bombard the metal and knock off minute particles. The specimen is then examined under a microscope. The treatment brings out the true microstructure of the metal with greater detail and clarity than could possibly be obtained by chemical etching. It permits taking unusually clear photographs of the curious stratalike pattern that indicates the direction of flow of the metal when forged.



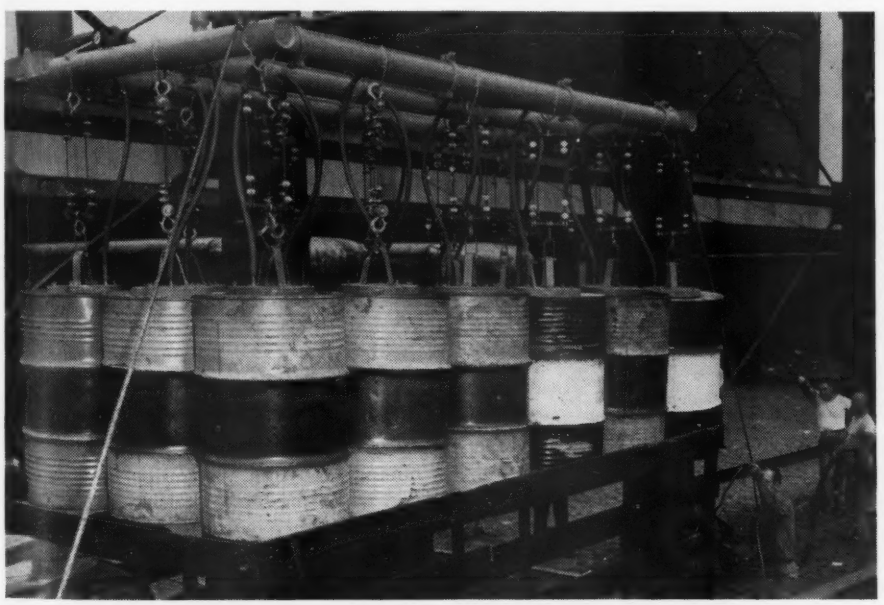
VACUUM GAUGE

This General Electric gauge gives a continuous record of the pressure in a vacuum system and responds almost instantly to pressure changes. Pressure can be read directly from a scale calibrated from 0 to 200 microns. In the 1-100 micron range the instrument is accurate within 10 percent of the reading, or 1 micron, whichever is greater. The model shown is portable and operates on 115-volt alternating current.

The use of vacuum during the manufacture of electrical cables and capacitors can increase both their life and their effectiveness. If products of this kind are subjected to a pressure of around 0.1 millimeter of mercury, even the smallest bubbles of air can be withdrawn from between the layers of material and the spaces filled with an insulating compound such as bitumen, paraffin, or other high dielectric. This operation is generally accompanied by internal heating to drive off all traces of moisture, etc.

Vacuum makes it feasible to simulate conditions that exist high above the earth's surface. For instance, Army ballistics researchers at the Aberdeen Proving Grounds study the flight of projectiles by means of a giant vacuum bottle 45 feet long. Fired at high speeds, the missiles are photographed as they travel from one end of the bottle to the other. The data thus obtained are useful in determining the effect shape has on an object's flight through rarefied atmospheres. As development in aircraft and rocket control continues, investigations like these become more and more important.

Thus, there are two main reasons why vacuum has proved itself to be an indispensable tool, for it permits not only the manufacture of products which cannot be made under atmospheric pressure but also an extremely high degree of control over processing conditions which, in turn, mean better finished products. On these counts, if on no others, we can look for more and better things to come tumbling out of industry's magic hat—vacuum.



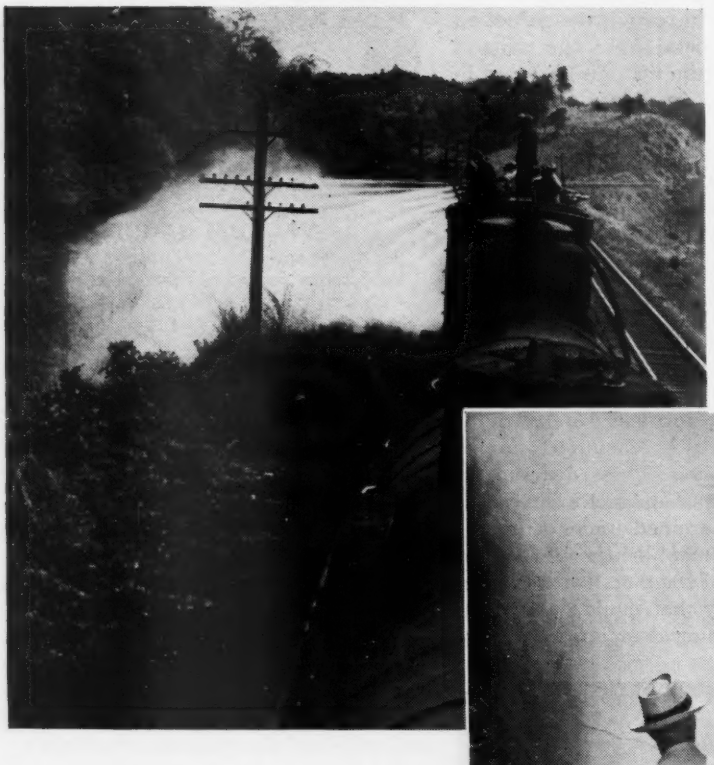
THE OCTOPUS

The vacuum process developed in the 1920's by Karl P. Billner to expedite concrete construction is being widely practiced the world over with equipment furnished by Vacuum Concrete, Inc., of Philadelphia, Pa., which Mr. Billner heads. Basically it involves creating a vacuum of around 23 inches of mercury within suction mats that are placed in contact with freshly poured concrete, thus removing some of the water and closing up the water voids. This enables finishers to start troweling within 30 minutes, permits stripping forms days earlier than usual, and increases the compressive strength by up to 50 percent. To handle heavy precast slabs, Mr. Billner designed a vacuum lifter, which has recently been applied to lifting and shifting loads of other kinds. The picture shows it loading eighteen drums of oil into a truck simultaneously. Essential parts are a vacuum pump of around 50-cfm. capacity, hose lines, and the suction holders. No slings are required, and the saving in time is obvious. Safety devices are always used and generally operate automatically. In a test, concrete mats prepared for use on Mississippi River revetments and connected to make a load of 2 tons, were unloaded from a barge in from 15 to 18 seconds, including the time needed to affix and release the safety devices. The multiple hoses needed prompted Mr. Billner to name his creation Octopus.

Battle of the Weeds

Special Equipment Helps Railroads Keep Rights-of-Way Free from Unwanted Growths

W. P. Gillingham



ADAPTABLE RIG OF SPRAY SERVICES, INC.

Two maneuverable 6-nozzle turrets, mounted on each side of a boxcar cut down at one end for the purpose, make it possible to take care of just about any spraying requirement. Each turret and each spray gun in any turret may be operated independently. These pictures and the one on the front cover show the equipment during demonstrations under varying conditions of terrain and vegetation. Spray Services, Inc., which developed this apparatus, has in recent years handled the weed-control work of several railroads, principally in the South.

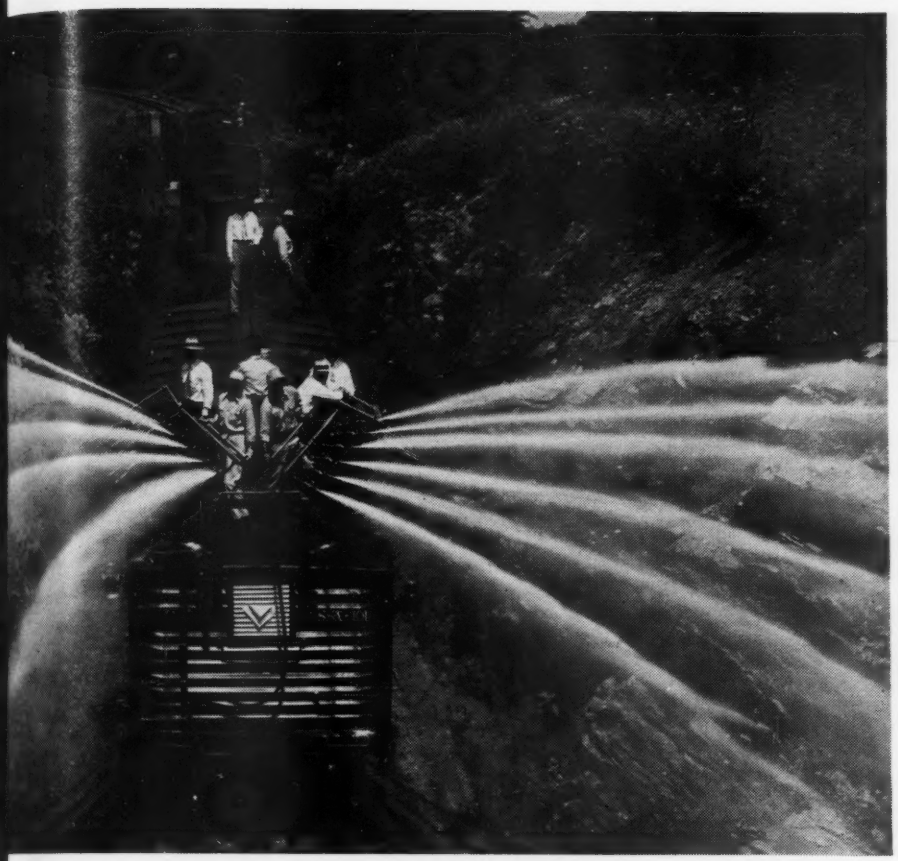
SUMMERTIME may bring joy to most of us, but not to railroad maintenance-of-way personnel. In the wake of April showers come not only May flowers but also a rash of weeds, grass, and brush. Springing up on roadbeds and along rights-of-way they obscure tracks, clog ballast, and create an appearance of general neglect. So every year, maintenance crews from coast to coast move out to do battle with the intruders.

It isn't just the urge to be good housekeepers that prompts the railways to keep their roadbeds clean and neat. There are sounder, more economic reasons. For instance, crushed stone or cinders are put under and between ties to provide good drainage. By allowing storm water to pass through freely, it gives the ties a chance to dry out quickly. When weeds and grass plug the openings between the pieces of ballast, ties remain wet for long periods, and that promotes the growth of fungi which rot the wood and shorten tie life. Besides, vegetation makes the normally expensive job of tie replacement even more costly because it must be removed largely by hand during the process. Finally, the retention of moisture that results from fouling of ballast by weeds and grass gives rise to an unstable condition of the roadbed that railroad men call "pumping ties" or "churning track." It produces an uneven track that slows trains and gives passengers a rough ride.

In addition to the roadbed proper, stretches on both sides of the ballasted section must be treated for vegetation control, but to a lesser degree. Grass is usually desirable there to prevent soil erosion, but tall weeds, brush, and trees must be curbed to prevent them from obstructing the vision of train crews or grounding transmission lines. Many railroads keep a strip from 2 to 5 feet wide on each side of the ballasted section free from weeds. As this necessitates treating about two acres per mile of track, the total area requiring attention on a big railway system is considerable.

Control measures may be of either a mechanical or a chemical nature. The former involves hand pulling, spading, hoeing, mowing, burning, and steaming, while the latter consists in applying chemicals in powdered or finely divided form or in solution. Because mechanical methods call for a great deal of hand labor they are no longer practiced widely. Of the dry materials used, ashes, salt, crude borax ore, and various industrial by-products have been given preference. But because their bulk and weight make them expensive to transport and difficult to spread, most roads now depend upon solutions which are applied by spraying. The predominating chemicals for this purpose are sodium chlorate, sodium trichloroacetate, sodium arsenite, boron compounds, thiocyanates, 2, 4-D, and different combinations of them.

Sodium chlorate is used extensively. It is mixed with deliquescent substances such as calcium and magnesium chlorides



that absorb moisture from the air and prevent the sodium chlorate from drying out and starting fires after it has been deposited. Creosote and petroleum derivatives serve as contact herbicides. Some of the chemicals are mixed with oil, some with water. A concentrate may be made up, shipped to the place where it is to be applied, and there further diluted with a liquid carried in drums or tank cars.

The concentration of spray required for good results depends upon the kind of vegetation to be treated, its density, the average annual rainfall, the texture of the soil, the length of the growing season, and the degree of control desired. Climate also has a lot to do with the establishment of an adequate weed-control program. In certain areas of the Southwest, for example, one application per season will suffice, while two or three applications of the same chemical may be needed in the Southeast.

As no single herbicide will curb all annual and perennial weeds and grasses satisfactorily and economically, considerable experimenting has been done by both railroads and suppliers of weed killers with combinations of different chemicals. The problem of selecting the right ones for given sections becomes one of determining what solutions are effective in routine application. The most potent materials are ineffective everywhere if improperly used. It is essential to keep them well mixed, to spray them so as to get proper distribution, and to apply enough to do the job.

Because of the numerous variables that affect the work and the divergent ideas of maintenance-of-way men as to how it can best be accomplished, vegetation control is more or less of an individual problem with each railroad. Most lines devise their own spraying equipment to meet their particular needs, and the rigs consequently vary considerably in construction, appearance, and operation.

The equipment designed and built by the Maintenance-of-Way Department of the Norfolk & Western Railway consists of five cars and a locomotive. The spraying apparatus is mounted in a box-car at the head of the train, together with a gasoline engine-driven centrifugal pump and other accessories. Two spray arms, that can be swung out from the sides, and a spray header across the front of the car make it possible to cover a strip about 40 feet wide with both arms extended. Individual valves control sections of the front header and side booms and a master valve shuts off all the nozzles when necessary.

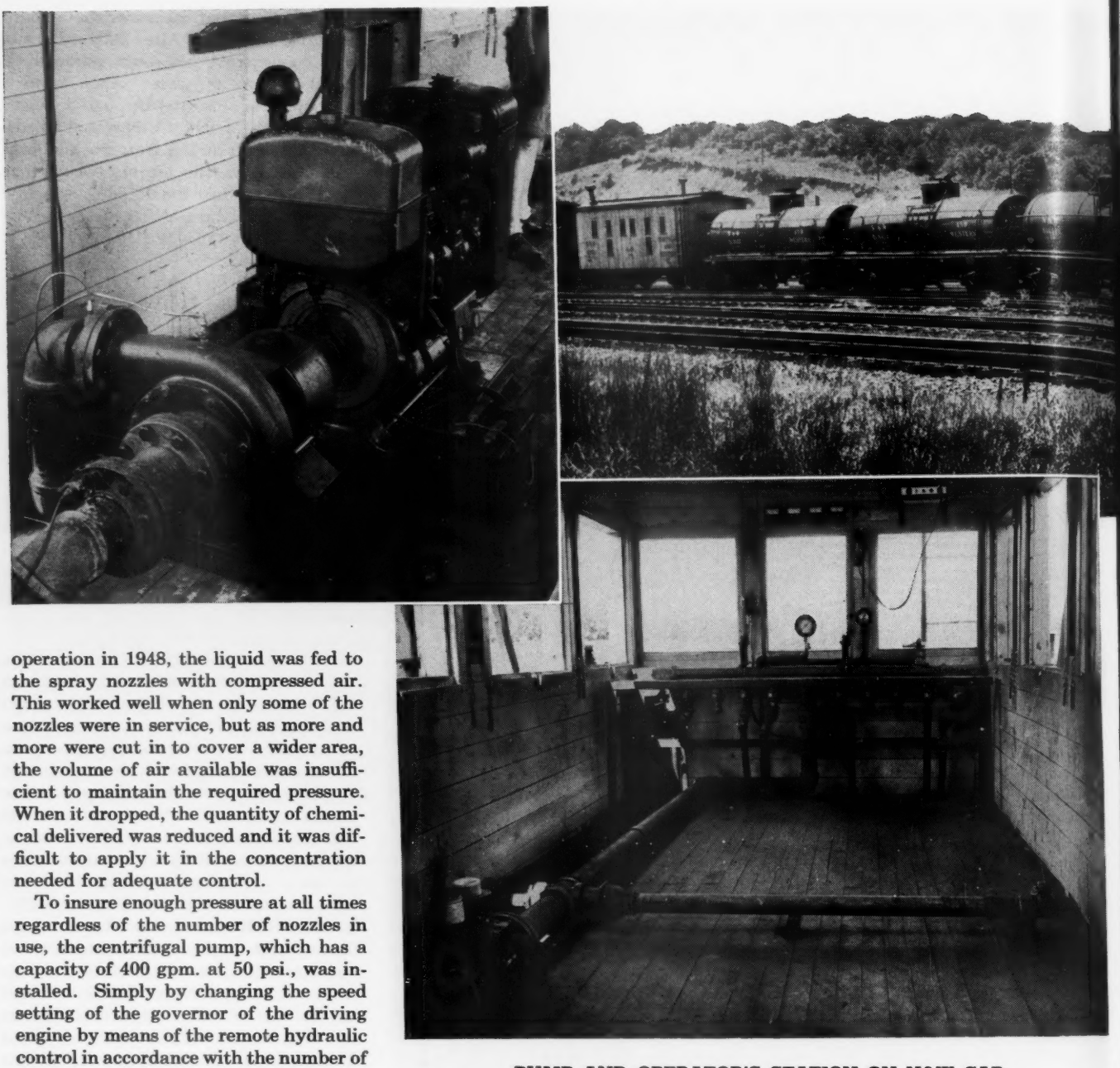
Behind the spray car are four tank cars each of which has a capacity of 8040 gallons. The chemical used is sodium chlorate, with enough sodium chloride added to absorb moisture after application. It is received in concentrated form in carload lots and transferred as needed into three of the tank cars by a small gasoline engine-driven pump mounted on the end of the last car in the train. It passes through a strainer and also a water meter that measures the amount entering each car. After 2000 gallons of the concentrate has been pumped in, 6040 gallons of water taken from a standpipe is admitted through a hinged cover on the dome. Compressed air, delivered by a train line from the air-brake compressor on the locomotive, is then introduced to mix the liquid thoroughly.

The chemical is supplied to the nozzles from the sump car immediately behind the spray car and is fed by gravity to the pump that serves them. As the liquid in the sump car is exhausted, it is replenished by forcing the contents of first one and then another of the three mixer cars into it by a self-priming pump driven by a gasoline engine. The purpose of the sump car is to eliminate the appreciable and variable pressure drop that would result if the main pump were to take suction through a long 4-inch line extending rearward to the mixer cars. Under those conditions, too, the pump would be in danger of losing its prime when the mixer cars were nearly empty. This cannot happen now because the sump car is kept approximately half filled by the action of a remote hydraulic control that governs the speed of the supply-pump engine. A 60-inch glass gauge on the car shows the liquid level, which is also indicated by a Levelometer in the spray car.

Because the nozzles on the arms are of the high-pressure type with extremely small openings, two strainers remove dirt, scale, rust, etc., from the chemical before it enters the main pump. Connected to each strainer is a duplex pressure gauge that gives readings on both sides of the strainer. If the latter is clean, the readings are the same; if it is stopped up there will be a pressure drop and the gauge readings will differ. Either strainer can be cut off for cleaning by closing valves without stopping spraying.

The equipment now in service is the result of considerable experimenting and will no doubt be altered in some respects from time to time as experience points out improvements. In setting out to build a rig, the problem, as the designers saw it, was one of furnishing facilities for depositing on each square foot of surface to be treated an adequate quantity of a suitable chemical to obtain the degree of vegetation control desired. Although this sounds simple, it isn't. There are too many variations in terrain, plant growth, width of spaces to be sprayed, etc. The amount of chemical that can be applied depends mainly on the pressure at the nozzles and the speed of the train. It is easy to regulate the latter by a speedometer on the spray car and a telephone to the engineer. But providing means of keeping the pressure constant proved more difficult because the number of nozzles in use changes continually in accordance with conditions.

When the equipment was first put in



PUMP AND OPERATOR'S STATION ON N&W CAR

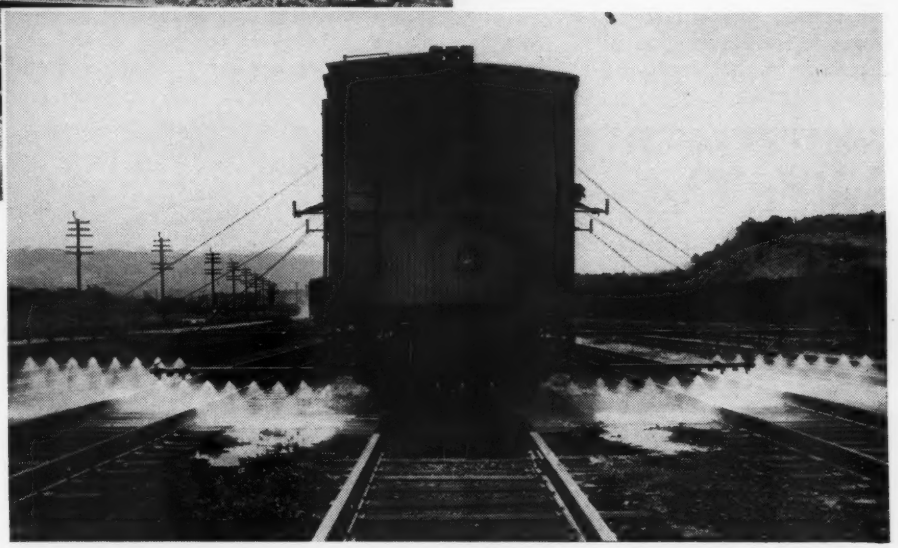
The spray mixture is pumped from the sump car, directly behind the spray car, by an Ingersoll-Rand gasoline engine-driven 4CRVL centrifugal pump (upper-left), having a capacity of 400 gpm. at 115 psi. pressure. The liquid enters the spray car by way of the pipe line at the left in the picture above. Just beyond the water meter in the lower corner is a cross connection that serves nozzles on booms on each side of the car. The main pipe then continues to a manifold at the forward end of the car where the operator stands with clear vision ahead and to the sides. At hand, he has seven individual valves with which to regulate the flow to different parts of the spray system and a master valve to cut off all the sprays when crossing roads or bridges. In front of him are a pressure gauge, a speedometer, and an odometer that indicates both daily and total mileage. On each side of the central window are hydraulic controls, one for the main spray pump and the other for the sump pump. A telephone keeps the operator in touch with the locomotive engineer so as to control the speed, which is normally 12 miles an hour. A dynamic loudspeaker hangs in the engineer's cab, permitting him to listen and talk without picking up a hand set. The operator can also stop the train in an emergency.

operation in 1948, the liquid was fed to the spray nozzles with compressed air. This worked well when only some of the nozzles were in service, but as more and more were cut in to cover a wider area, the volume of air available was insufficient to maintain the required pressure. When it dropped, the quantity of chemical delivered was reduced and it was difficult to apply it in the concentration needed for adequate control.

To insure enough pressure at all times regardless of the number of nozzles in use, the centrifugal pump, which has a capacity of 400 gpm. at 50 psi., was installed. Simply by changing the speed setting of the governor of the driving engine by means of the remote hydraulic control in accordance with the number of nozzles in service, the pump maintains well-nigh constant pressure on all or any group of the 29 nozzles on the spray train. The amount of chemical sprayed by each nozzle thus remains the same.

To make sure that different kinds of vegetation will receive the dosage they require, R.P. Winton, testing engineer of N & W's maintenance-of-way department, worked out a table to be followed. The discharge of the nozzles at varying pressures was calibrated by means of a water meter and a stop watch and plotted. Curves and tables were then prepared to show the pressure needed to give weeds the prescribed dosage and Bermuda grass twice the normal dosage at different train speeds. With this information in front of him, the operator adjusts the speed of the main-pump engine by means of the hydraulic control to provide the desired pressure at the speed indicated by the speedometer. For example, if the train is making 10 miles an hour, the pressure at the manifold for normal dosage will be 12.2 psi., but 32 psi. for extra dosage. At 12 miles an hour, the respective pressure requirements will be 19 and 51.5 psi.

The combination of a pump that maintains constant pressure under varying load conditions, of large piping that minimizes pressure drop, and of a short suction line from the sump car that insures little change in the suction head makes for close pressure control at all times. This is evidenced by the fact that when the operator adjusts the pump-engine speed to meet prevailing conditions, the pressure varies less than 1 psi. as valves controlling the spray nozzles are turned off and on. When he sees



NORFOLK & WESTERN TRAIN

The first of the four tank cars behind the spray car (picture at left) is a sump car that is kept half full of the chemical to insure the pump that powers the spray guns constant suction pressure. The three others are mixer cars that carry a large supply and replenish the sump car as the solution is withdrawn. Below is a close view of the spray headers. When not in use, the arms are swung in close to the car.

Bermuda grass in front of him, he can increase the speed of the pump engine in a few seconds to supply the additional dosage specified for this growth.

The Delaware, Lackawanna & Western Railroad has a spray car which, like the N & W's, is equipped with a centrifugal pump to force the chemical solutions through the nozzles. It includes pneumatically operated and controlled spray arms that can be extended 32 feet from the rail on each side, can be moved backward or upward to clear tall trees and signals close to the track, and can be folded flat on the car when not in service —all by merely turning air valves.

Each arm has fifteen nozzles, seven on the larger beam and eight on the extension. When both are fully run out, a strip nearly 70 feet wide can be covered. They are used mainly for treating brush and tall weeds, which are usually found at some distance from the track. In narrow, steep-sided cuts and other restricted areas, the pneumatic arms are collapsed and spraying is done with a swivel-mounted length of pipe that throws out a cloud of finely dispersed liquid. Neither are they brought into play where weeds and grass only are to be treated. Instead, the hoses carrying the chemical from the tank cars are disconnected and hooked on to another car, which is equipped with a fixed spray header that covers the ballasted area and with telescoping spray arms that can be swung out manually on each side and extended pneumatically to reach about 30 feet from the near rail. An Ingersoll-Rand Size 2CRVH centrifugal pump having a capacity of 160 gpm. under a 116-foot head and driven by a Waukesha 16-hp. engine serves the sprayers.

John P. Hiltz, Jr., engineer, Maintenance-of-Way Department of the D. L. & W., adds the following concerning the operations: "For brush spraying, we use . . . chemicals containing the esters of 2, 4-D and 2, 4, and 5-T. They are used in equal parts in a solution of one part chemical to 100 of water. We have found that such a spray kills about 80 percent of our brush. The notable exceptions are maples and ashes. We brush-spray about 1600 miles of right-of-way to an average width of 30 feet once a year, usually in June, and use about 260,000 gallons of spray solution.

"For weed spraying, we used in 1950 a formula of 7-BD . . . . This is diluted 12 parts to one with oil. Our 1950 operations covered 1850 miles of right-of-way, including the track area where necessary and up to 15 feet on each side of the rails. We used about 9000 gallons of chemical, or around 117,000 gallons of solution. Our weed spraying is normally all done in July."

Not all railroads do their own spraying. Several, including the Seaboard Air Line, Louisville & Nashville, Chesapeake & Ohio, and the Detroit, Toledo & Ironton, have contracted this work in recent years to Spray Services, Inc., of Huntington, W.Va., a firm whose president, J.P. Quarles, believes that a specialized service of this kind can best be handled by an organization that makes a business of it.

Like the railroads, Spray Services, Inc., has spent considerable time and money in developing the most economical and satisfactory apparatus and operating technique. The evolution of its equipment, on some features of which patents are pending both here and abroad, is described by Mr. Quarles as follows:

"The sprayer was built after considerable experimenting with a single turret, or battery of six guns, which we mounted on a platform built on top of a flatcar. This work was carried out on the Seaboard Railroad in the summer of 1949, at which time we also did considerable experimenting with different types of chemicals, varying the quantities and the dilution with water to determine the most effective quantities per given area.

"The object of the turret was to provide a flexible means of spraying the sides of banks, the tops of cuts, or depressions below the railroad grade, without having any obstacles interfering with the spray. The turret is built so that it can be traversed, or tilted at an

angle to the traversing plane and, also, be elevated or depressed. These three directions of movement permit us to spray under practically any condition of terrain. Each of the six spray guns can be operated individually, so that the width of area to be sprayed can be varied to meet practically any condition.

"After spraying with one turret on one side, we found that many times, going through cuts, we wanted to spray the side of the cut with one turret but it would be necessary for us to have an additional turret with which we could spray the top of the cut. In other words, the terrain dictated that there be two separate turrets on each side. After determining what would be required to spray one side, we decided that we could spray both sides at the same time and, therefore, we mounted two turrets on each side.

"In order to direct the spray downward as much as possible and reduce the drift, we went as high in the air as possible while still maintaining standard railroad clearances. Incidentally, this also helps us to get better coverage when going through very high cuts. There is no part of this equipment that won't clear 14 feet from the rail.

"We started with a standard boxcar and cut down one end of it so that we had a platform approximately 5½ feet above the floor at the back of the car. This platform extends from the rear end approximately 14 feet forward and runs the full width of the car. The four turrets are placed two on each side, as near the sides of the car as possible with all parts within standard clearance limits, and are fixed permanently to the platform.

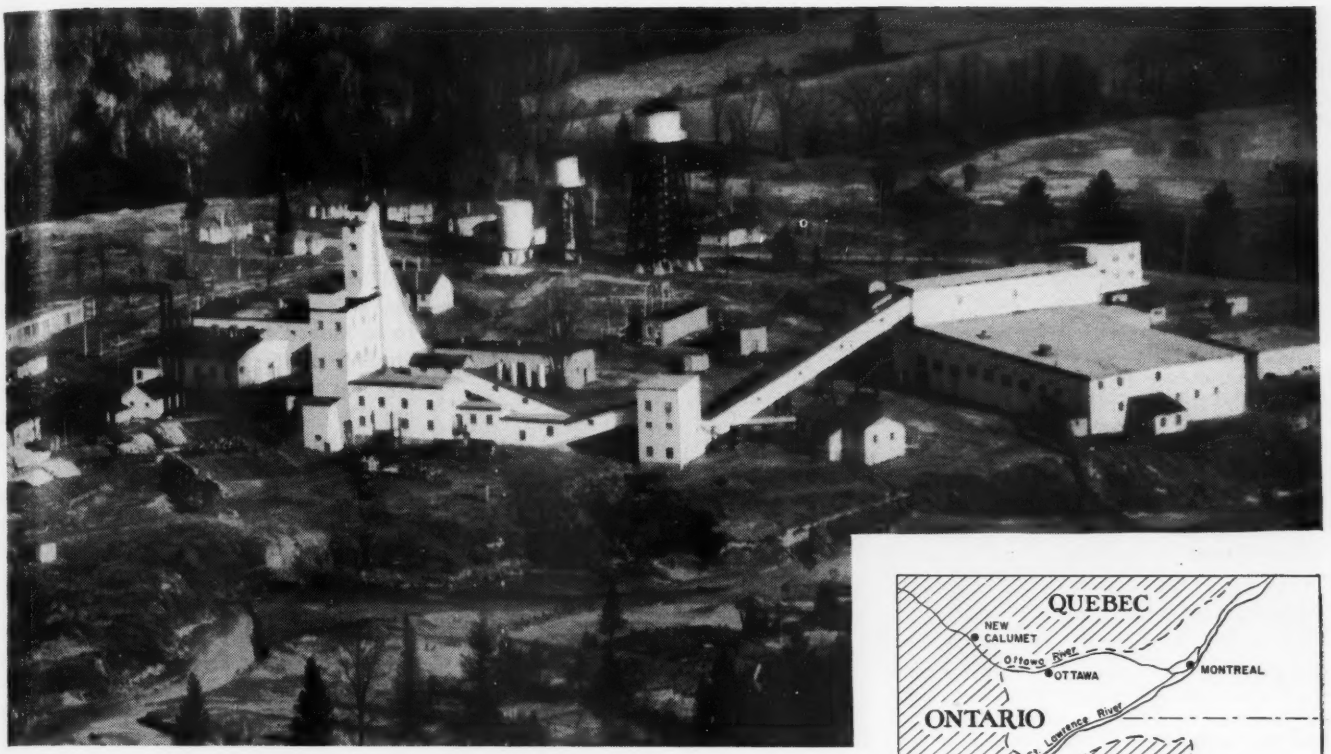
"The supply lines that furnish the spray to the guns come from two centrifugal pumps, each powered by a 60-hp. engine mounted side by side in the boxcar and directly beneath the platform. The lines run from the pumps up through the platform into the bottom of the turrets and the material is transmitted through the turrets to the spray guns. Normally, one centrifugal pump can supply sufficient material to operate all four turrets, but we have two pumps and engines so that, should one fail, the other could immediately be cut in. This prevents considerable work-train delay in case of engine or pump failure.

"Each of the pumps is capable of developing 350 pounds pressure and has a capacity of 550 gpm. We have found that we get our best results when operating at a pressure of 100 to 150 pounds. When the train is operated at a speed of 6 to 8 miles per hour the spray guns are capable of throwing the spray solution a distance of 60 to 70 feet from the center of the track and, 90 percent of the time, we can spray a full 100-foot right-of-way.

"Normally, we use four tank cars as mixing cars for the spray equipment and they are connected together and to the spray equipment by means of large pipes and hose. The tank cars are filled with water at regular railroad standpipes and the brush killer is pumped into the tank cars in the ratio of 1 gallon of chemical to 100 gallons of water. Agitation is provided in the tank cars by means of compressed air. The mixed solution is then pumped by the main pumps, located on the spray equipment, from the tank cars and forced out through the spray guns on each of the four turrets."

LACKAWANNA SPRAYER IN ACTION

For covering a wide strip, and used mainly where brush and tall weeds flourish, pneumatically operated arms, each with fifteen nozzles, are extended on each side of the spray car, as shown in the view above. It was taken when the train was in a deep cut. In more restricted areas, a length of pipe, mounted on a swivel like an antiaircraft gun, can be manipulated by hand, as seen at the right. For trackside work where no brush is involved it is customary to use the spray arms on the near end of the boxcar shown in both pictures.



VIEW FROM THE AIR

Lead and zinc were discovered here in 1893 by John Lawn. Beginning in 1898, several operators, working intermittently, sank a shaft 85 feet and drove a few hundred feet of drifts and crosscuts. Activities ceased in 1916 when all surface structures burned. A group optioned the property in 1926, unwatered the shaft, did 300 feet of underground development work, then quit. Calumet Mines bought the assets in 1937, prospected by diamond drilling until 1940, and disclosed reserves of 1,300,000 tons of ore averaging 8.82 percent zinc, 2.75 percent lead, and small amounts of gold, silver, and copper. The present owners took over the property in 1942. The picture shows the main surface plant with the headframe of No. 1 Shaft at the left and the mill at the right.

LOCATION MAP

New Calumet Mines is situated on a 11-mile-long island in the Ottawa River and 60 miles upstream from the City of Ottawa. The Grenville formation of pre-Cambrian rocks, which carries the ore both at the New Calumet and at the Edwards and Balmat mines in New York State, is indicated by cross-hatching.

New Calumet Mines

Wartime Venture Aimed at Boosting Base-Metal Output Develops into Profitable Operation

W. M. Goodwin

THE Ottawa River, from its juncture with the St. Lawrence at Montreal upstream for a distance of 300 miles, has played a notable part in the history of Canada. During the seventeenth century it was the canoe route of the early explorers Champlain, LaSalle, Joliet, DuLhut, and many others when they set forth to find out what lay in the vast interior of the new continent. Then came the voyageurs and the "brigades" of the fur traders.

A century ago the Ottawa Valley was the center of the Dominion's timber trade, furnishing the huge, hand-hewn white pines that were floated down to Quebec and loaded into sailing ships for England. Today the lower half of the valley is one of Canada's chief dairying regions. The upper half, still largely wooded, is notable for its waterpower resources, which will yield about 1½ million horsepower when fully developed.

On an island 60 miles west of the City of Ottawa and in the midst of the watershed there is a zinc-lead mine, discovered about 60 years ago but brought to the point of production only in 1943 as a war-aid measure. New Calumet Mines is in a pleasant setting of forest and field, with the Rocher Fendu Rapids close by. With a payroll not far from a million dollars a year, it has brought to this section of the valley even more prosperity than it enjoyed in the heyday of lumbering.

The pre-Cambrian rocks of this part of the provinces of Ontario and Quebec belong to the Grenville formation, which extends unbroken across the St. Lawrence into New York State, where it composes the Adirondack Mountains. On the western side of the latter and only a few miles apart are two well-established zinc-lead mines, Balmat and Edwards, operated by the St. Joseph Lead Company. In Quebec, 200 miles east of the New Calumet, there is a similar zinc-lead mine—the Tetreault. All four of these properties are associated with the crystalline limestone and gneiss of the Grenville formation.

The New Calumet ore bodies are in the gneiss. The ore evidently originated from the intrusive granite that pervades the region and was concentrated in the gneiss by the process of replacement. It is sometimes massive, but generally consists of disseminated sphalerite and galena within a gangue that is composed predominantly of calcite and lime-silicate minerals. Minor amounts of pyrite, pyrrhotite, and chalcopyrite are associated with the ore.

The deposits are more or less lenticular

SUMMARY OF OPERATIONS YEAR ENDED SEPTEMBER 30, 1950

Tons milled (daily average 698)	254,977		
Average return per ton			$17.74
Metal production:			
Zinc (28,334,789 pounds)	$2,956,501		
Lead (8,360,605 pounds)	862,709		
Gold (4446 ounces)	156,341		
Silver (729,946 ounces)	548,453		
	$4,524,004		
Operating costs per ton treated:			
Development	$0.56		
Mining	3.21		
Milling	1.05		
Assaying	0.04		
Hauling, stockpiling concentrates	0.22		
Mine office and supervision	0.26		
Administrative and general expense	0.84		
Depreciation	0.47		
		$6.65	
Other costs:			
Smelting and marketing charges	4.97		
Duty, zinc	0.62		
Freight	1.24		
		6.83	
Provision for income taxes		1.04	
Cost per ton			14.52
Net profit per ton			$3.22

and can be followed from level to level in the mine, particularly the Longstreet which extends continuously beyond the deepest drilling for a proven length of 2400 feet. In this it is distinct from the Balmat ore bodies, which are podlike and discontinuous and have to be found by systematic drilling on each successive level. But in a general way those of the New Calumet, Balmat, and Edwards mines are essentially alike, both geologically and mineralogically.

A Wartime Enterprise

The early attempts to work the outcrops were foredoomed to failure for two reasons. The modern technique of close-spaced drilling to find the ore was not used and the flotation process for separating the mixed sulphides was not available. In the years 1937-40 the property was explored thoroughly by Paul Armstrong, a geologist from Montreal, a total of 97,000 feet being drilled. This outlined the ore to a depth of 600 feet and indicated it to a level 600 feet deeper, the indicated reserve being 1,300,000 tons averaging 8.82 percent zinc, 2.75 percent lead, 6.24 ounces of silver, and 0.041 ounce of gold.

Late in 1942, Nesbitt, Thomson & Company, of Montreal, and Ventures Limited, of Toronto, joined forces to develop the mine as an aid to the war effort. It was brought to production under the direction of J. M. Cunningham-Dunlop, now managing director. With the low prices for metals set by the allied governments there was no assurance that the moderate-grade ore would repay expenses, so a plan was adopted that would permit production in the shortest possible time and with the least capital expenditure. A vertical shaft was put down to extract the ore to a depth of 600 feet. It intersected the principal ore bodies between the 300- and 400-foot level and permitted rapid and economical stoping in this section of the mine.

A complete milling plant was available at the Stirling copper-lead-zinc mine in Nova Scotia. This was purchased, reconditioned, erected on its new site during 1943, and augmented slightly to give it a capacity of 500 tons a day. The mill was turned over late that year, and by the end of September, 1949, the mine had produced 1,127,921 tons of ore, which yielded 74,076 tons of zinc, 21,174 tons of lead, 3,172,880 ounces of silver, and 13,880 ounces of gold. The ore reserve at that time was 888,942 tons, averaging 8.2 percent zinc, 2.6 percent lead, 5.04 ounces of silver, and 0.033 ounce of gold—somewhat more than three years' supply at the present rate of milling.

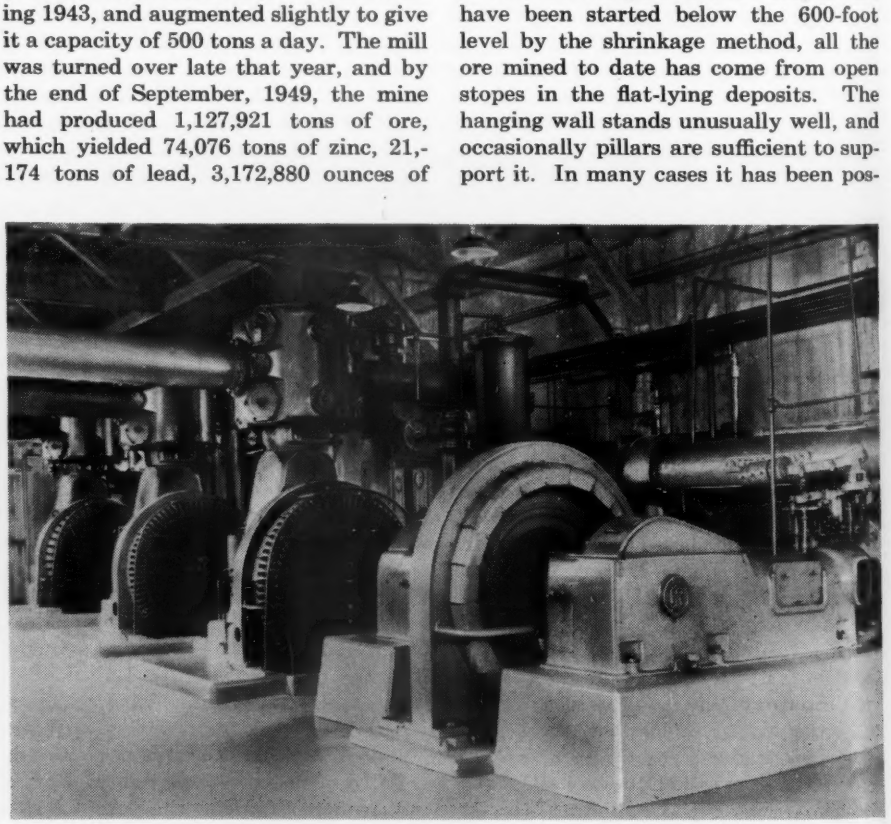
The Ore Bodies

Down to 600 feet the dip of the deposits is 35 to 40° and the broken ore has to be moved from the open stopes on to loading platforms by slushers. Below 600 feet the only deposits opened so far are the Longstreet and the adjacent Bowie, both to a depth of 1350 feet. The Longstreet ore body dips about 57° from the 600- to the 1200-foot level and has a flat dip of 1200 to 1350 feet. The Bowie has all flat dips. In these lower levels the dip is considerably steeper, averaging 57° so that shrinkage stoping is possible.

Development of the MacDonald, Russel, and Ste. Anne deposits is still far from complete; but the evidence to date suggests that they do not continue to so great a depth as the Longstreet. There is plenty of room for the discovery of additional lenses along the ore-bearing zone, both laterally and at depth.

Mining Methods

With the exception of a few stopes that have been started below the 600-foot level by the shrinkage method, all the ore mined to date has come from open stopes in the flat-lying deposits. The hanging wall stands unusually well, and occasionally pillars are sufficient to support it. In many cases it has been pos-



COMPRESSED-AIR PLANT

The mining system, which is determined by the nature of the ore deposits, requires a large labor force and generous quantities of compressed air to operate drills, hoists, mucking machines, etc. The air needs are supplied by four Canadian Ingersoll-Rand compressors. The three rearward units are 300-hp. XVH models. The machine in the foreground is a 200-hp. Class PRE.

sible to leave pillars where the ore is lean, so there is not a great deal of good ore tied up.

To begin a stope, the drift walls are slashed to full ore width and the back is taken down until the hanging wall is reached. Following this, a slice is cut against the hanging wall for the length of the ore body and up the dip to the floor pillar of the level above. If the width of the ore is greater than that which can be conveniently removed by this initial slice, the remainder is stoped by the benching method. In different stopes the width of the ore varies between the limits of 5 feet and 50 feet. When stoping areas of wide ore, great care is taken to leave a smooth and regular hanging wall. By observing this precaution there have been no rock falls during the subsequent active life of the stopes.

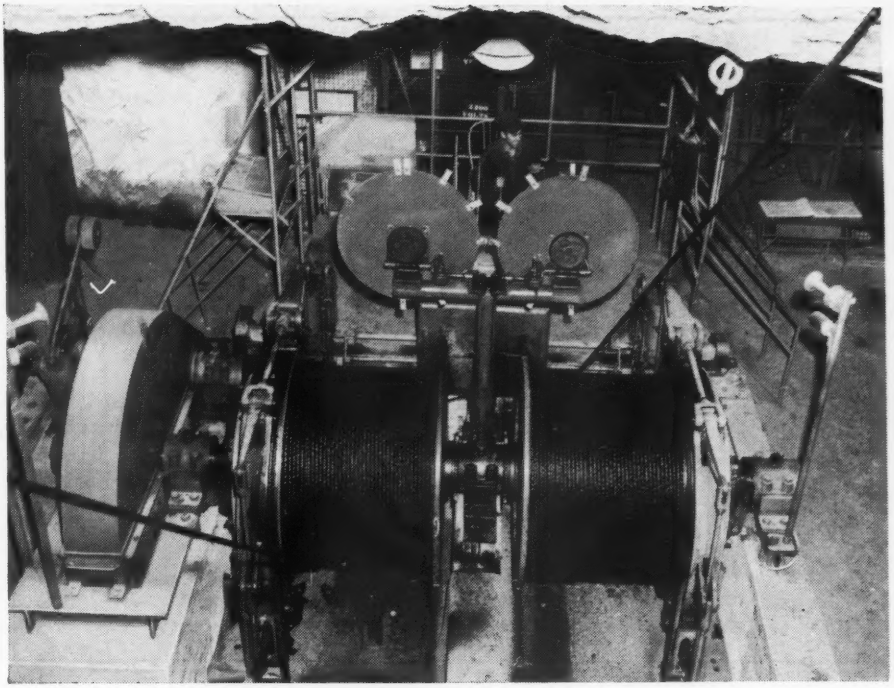
While a stope is being opened for a distance of about 35 feet up the dip from the drift, broken ore is mucked by mechanical loaders. When this stage has been reached mining is stopped, the stope is cleaned out, and a timbered ramp is installed. This is generally of the style illustrated, but differs with the size of the opening, which depends upon the width of the ore. Thus, while the drawing shows a ramp above double track with room for a slusher behind the discharge hole, a variation in ore thickness or dip may permit the erection of only a platform with the discharge hole in it, and the slusher may have to be placed to one side or else up in the stope. As a rule, waste rock is left in place when it is possible to obtain a workable arrangement by changes in design. Once the ramp is completed, stoping is resumed and the broken ore is scraped down the stope and into cars that are spotted underneath the ramp.

While the ramp pictured may appear to be large and, perhaps, expensive, compared with other methods of slushing into cars from flat-lying stopes, it provides the operator with excellent visibility and free working space, which result in increased output per man-shift. In these days of high labor cost, this weighs heavily when considering the initial installation cost.

Throughout the mine there are fourteen electric slushers with motors varying from 15 to 30 hp. and six compressed-air slushers of 7½ hp. The scrapers are homemade. Those for the air type are 36 inches wide, while the 15- and 20-hp. electric units have 42-inch and the 25- and 30-hp. slushers have 48-inch scrapers.

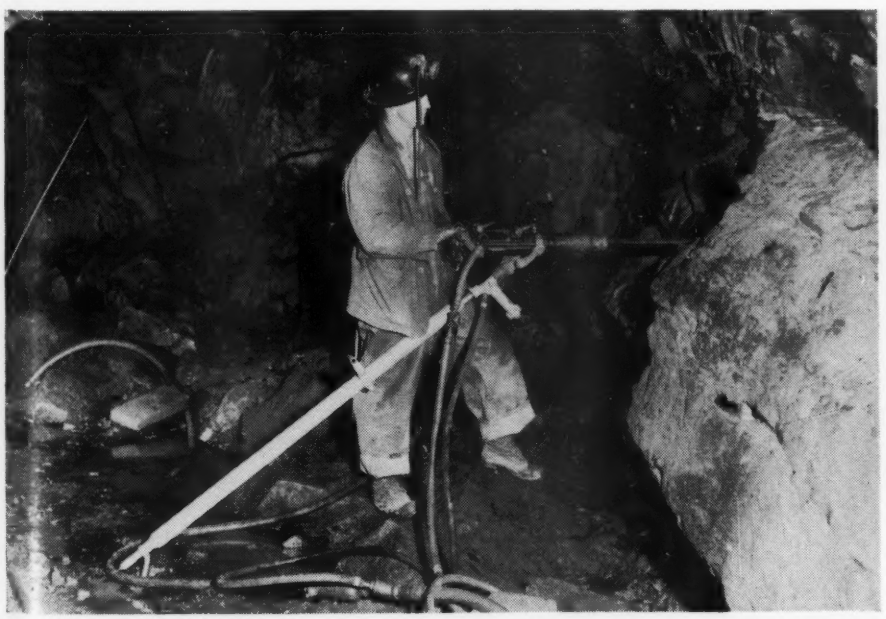
Ore is loaded from the ramps into 30-cubic-foot, side-dump cars grouped into trains of eight or ten drawn to ore-pass grizzlies on each level by a 1½-ton battery locomotive. There are 89 ore cars and six locomotives in use for stoping and development purposes. Grizzlies are made up of three 90-pound rails 13 inches apart.

All ore and waste from the 600-foot level and above enters an ore-and-waste-pass system which converges on a loading pocket in No. 1 Shaft. From this pocket, which is 50 feet below the 600 level, the material is raised in 2¼-ton skips to headframe bins. Ore and waste from the area between levels 600 and 1500 are hoisted in cars up No. 3 Winze to the 600 level and hauled in trains to the respective grizzlies. Of the total ore cars and locomotives mentioned in the preceding paragraph, 44 cars and two locomotives are used in the latter area. Mechanical muckers are utilized in development headings and where stopes



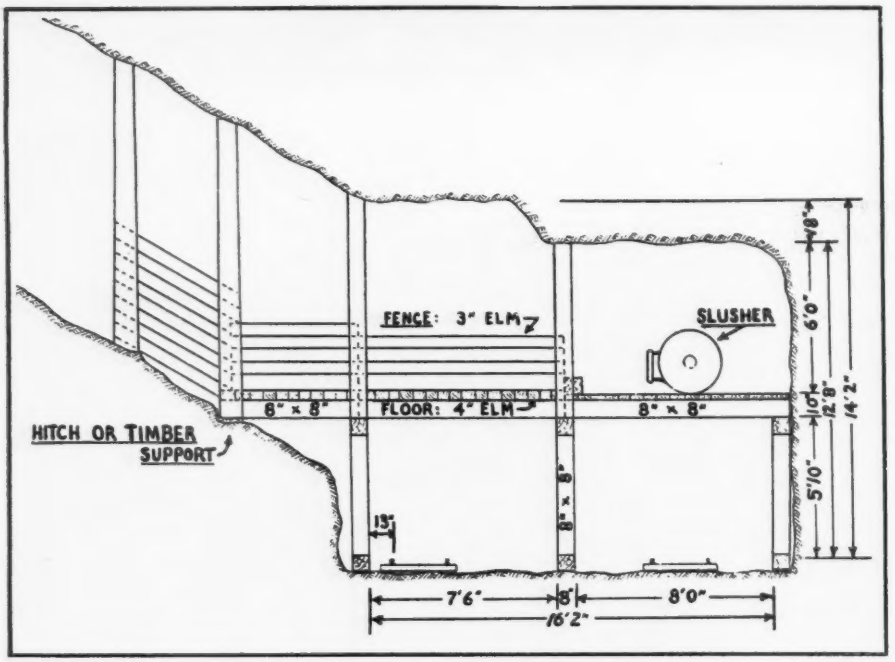
UNDERGROUND HOIST

Two vertical shafts extend from the surface to a depth of around 700 feet and a winze runs from the 600 level to below the 1500 level. No. 1 Shaft and the winze are served by identical Canadian Ingersoll-Rand double-drum, 150-hp., electric hoists. The underground unit is pictured.



DRILLING WITH A JACKLEG

Approximately 30 drifters, 15 stopers, and 25 hand-held drills of the Jackhamer type are used in underground drilling. This picture shows the adaptability of the Jackleg, a pneumatic column support for a hand-held drill that lightens the drill runner's job. Holes can be put in at any level with little human effort. The machine shown is a J-50 Jackhamer.



SKETCH OF SLUSHER RAMP

As most of the ore bodies are not steep enough for broken ore to move downward freely by gravity, scrapers powered by slusher hoists are utilized for loading cars. Shown is an elevation sketch of a typical timber ramp extending up into a stope and outward across a 2-track haulageway. A cable-drawn scraper, powered by a hoist stationed near the right side, brings the ore down for loading through a 2x3-foot opening in the floor over the track at the left. There are many variations of this ramp to fit different conditions.

General Services

Electric power is supplied by the Bryson hydroelectric station of the Gatineau Power Company, 4 miles away on the Ottawa River, where 70,000 hp. is generated. The mine contract calls for 2900 hp., and the average consumption is 2750 hp. Because the load is considerably greater than this, the crusher and then successive compressors are cut out automatically as the permitted peak is approached. Because the Bryson plant is interconnected with other stations in a great regional system, the hazards of power failure are therefore minimized. The rate charged for current is reasonable.

The mine is in a settled countryside, and for that reason the capital outlay for dwellings, a school, roads, and other facilities has been slight. A few homes, a small bunkhouse, and a dining room have been provided. Most of the employees, now 350-360 in number, live up and down the Ottawa Valley throughout a stretch of 40 miles. Buses, subsidized by New Calumet Mines Limited bring many of the men to work. All told, the mine has gained a good deal from being in a well-inhabited district, and the surrounding area has benefited greatly from the mine.

are being started. There are ten in wellnigh continual service.

It will be gathered from this recital of mine conditions, and the mining methods adopted to suit these conditions, that an unusually large labor force—about 200 men underground—is required for a mine the size of the New Calumet. The scattered, flat-lying ore bodies make this inevitable. Nevertheless, by close attention to unit costs, operating details, and man-shift production, reasonable mining costs are attained, as an accompanying table shows.

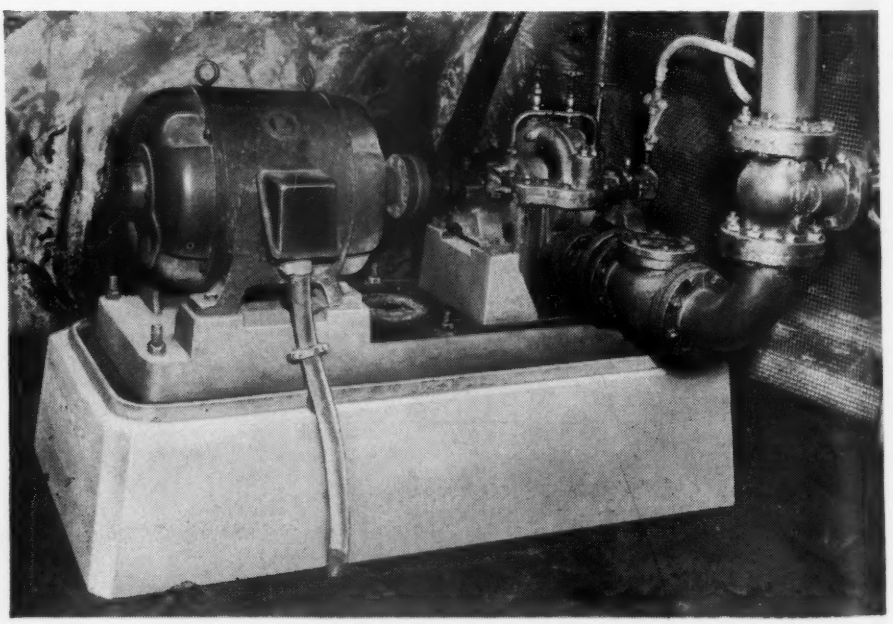
Milling

Crushing, grinding, and selective flotation follow the usual milling practice. Though the mill was designed to treat 500 tons a day, the recent addition of a fourth ball mill and another bank of lead flotation cells has increased its capacity to approximately 800 tons. The concentrates are trucked to the railway at Campbell's Bay, a distance of some 10 miles, the zinc concentrate being shipped to England and the lead to The Consolidated Mining & Smelting Company at Trail, B. C.

It is only the increase in the price of lead and zinc since controls were lifted that has permitted this wartime venture to persist and to become a profitable operation. The first dividends were paid in 1949. G. H. Mustard is general superintendent, W. J. Tough is mine superintendent, and W. H. Timm is mill superintendent.

MILL RECORD FOR THE YEAR ENDING SEPTEMBER 30, 1949

	Tons	Zinc Percent	Lead Percent	Silver Ounces	Gold Ounces
Ore treated	212,441	5.67	1.65	3.29	0.019
Zinc concentrate	21,524	51.92	0.37	3.03	0.011
Lead concentrate	6,540	6.19	48.55	73.77	0.433
Recovery	—	92.70	90.30	69.00	71.700



DRAINAGE PUMP

To collect and lift an average of a little more than 200 gpm. of water from the workings, seven pumps of different sizes are used. The one shown is a 60-hp., 2-stage GT centrifugal with a capacity of 225 gpm. against 650 feet of head. It is stationed on the 1200 level.

Pneumatic Press Drives Two Nails at a Time

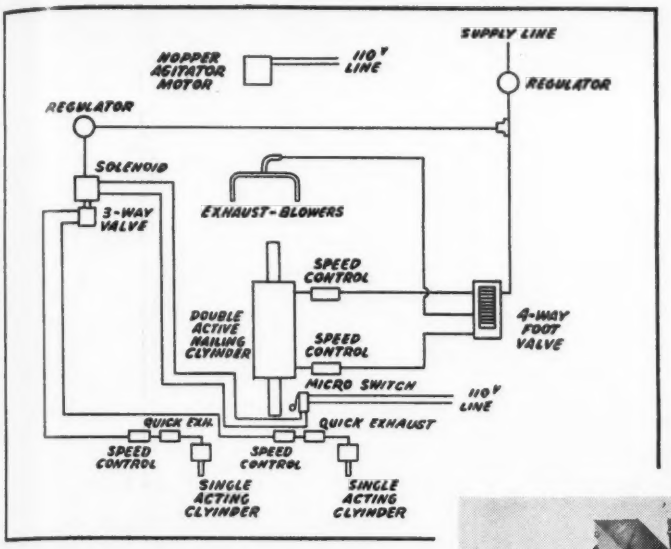
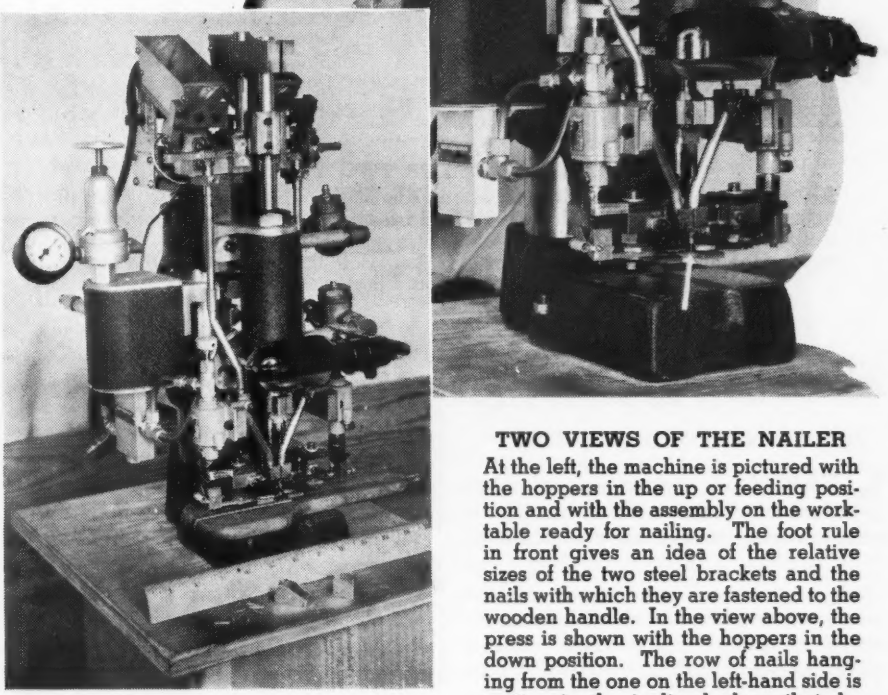


DIAGRAM OF CONTROL SYSTEM

The exhaust air from the 4-way foot valve, which operates the main 2-inch-diameter pneumatic cylinder, is directed through copper tubes into inclined planes in the hoppers which deliver the nails to the cams or carriers, thus giving the nails an added impetus. On the upstroke of the cylinder, a collar on the piston pushes the spring-return cams outward to the feeder tubes into which the nails are deposited. On the downstroke the cams return to their starting points. The small secondary air cylinders, actuated by a microswitch, control the movements of the jaws that hold the nails and align them with the holes in the steel brackets that are fastened to the wooden handles of the hooked-rug needles. Speed-control valves in the circuit serve to cushion the pneumatic cylinders and to insure proper timing.



TWO VIEWS OF THE NAILER

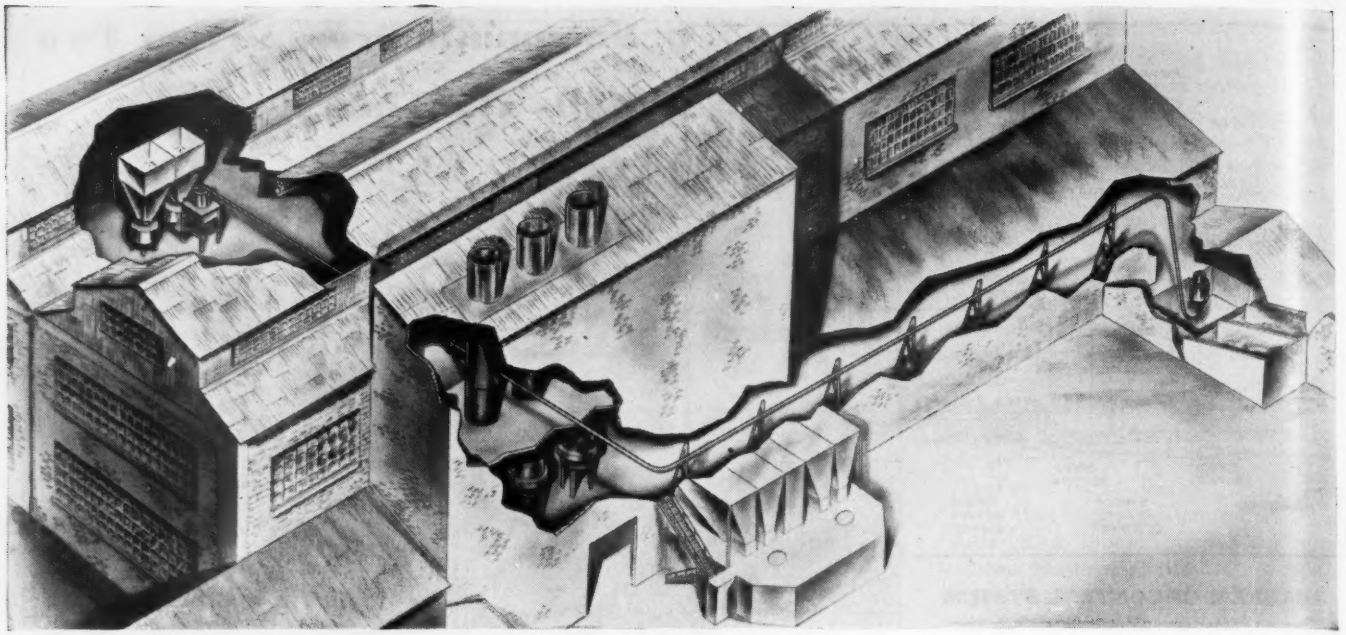
At the left, the machine is pictured with the hoppers in the up or feeding position and with the assembly on the worktable ready for nailing. The foot rule in front gives an idea of the relative sizes of the two steel brackets and the nails with which they are fastened to the wooden handle. In the view above, the press is shown with the hoppers in the down position. The row of nails hanging from the one on the left-hand side is resting in the inclined plane that delivers them, one by one, to the associate cam. The three arrows point, respectively, to two nails approaching the feeder tubes and to one of the jaws holding a nail in driving position.

SLOW-DOWN in production is often occasioned where most operations in a sequence are done mechanically and one or more by hand. Design engineers have been kept busy overcoming such bottlenecks not only to keep the work moving at a steady pace but, sometimes, also to prevent loss through wastage. Wilson Brothers Company, maker of hooked-rug needles, was confronted with a situation of this kind, which has been successfully solved for it by The Crusota Engineering Company of Springfield, Mo. The latter built a machine of a special type for nailing two steel brackets to a hard cherry-wood handle that holds the needle, a job that was formerly done manually and was costly on two counts: it took too much time and often resulted in bent nails and split wood.

The new machine differs from nailers now on the market in two respects. To quote the manufacturer, it permits of "infinite nail location and definite driving pressure." Most of its working parts are in duplicate, making it possible to drive two nails simultaneously. At the top are two hoppers, each of which holds 300 nails which are agitated by an eccentric arm actuated by a low-speed motor through a ladder chain. This puts the nails into feeding position. During the upstroke of the press two nails, one from each hopper, are released and carried by cams to feeder tubes through which they drop into jaws directly above the work, which is accurately located on the table in relation to the nails. The holes in the brackets are 0.004 inch larger than the nails, which are 0.048 inch in diameter, making spotting an exacting operation.

The nails are driven by air hammers or punches which are actuated by a double-acting pneumatic cylinder controlled by a 4-way foot valve and using air at 160 psi., line pressure. As the hammers descend they come in contact with the tubes, which converge at the bottom, and push them outward. Farther along in their downward travel a cam on the punch holder trips a microswitch which energizes a solenoid 3-way valve. The latter controls the movements of two tiny pneumatic cylinders operated with air at 30 psi. These cause the jaws to close on the nails and to align them with the prepunched holes in the steel brackets, which are held in place by guide plates. Then nailing begins, and when the hammers are just above the jaws the 3-way valve is deënergized, the pistons of the small cylinders retract, and the jaws open, allowing the punches to pass between them and to hammer the nails home at a pressure of 500 psi.

The nail used is of the screw type to insure a firm grip. Though the grooves cause it to turn outward from its common center as it is driven, the design of the punch is such as to align it with an accuracy of 0.002 inch, plus or minus. In a test run of 150 assemblies, which involved driving 1200 nails, no handle was damaged and no nail bent. The machine has been in operation for more than a year and in that time has trebled production.



IN OPERATION FOR TWO YEARS

Structural features of the Turbo-Drive and schematic cutaway of the 262-foot installation in one of Crane Company's foundries. The pneumatic conveyor is at the right and delivers facing-sand addition in batches of 1200 pounds through a 4-inch pipe line with compressed air at 60 psi. Note the few bends in the system, which is entirely enclosed for cleanliness and protection of materials.

Air Conveyor Handles Material in Batches

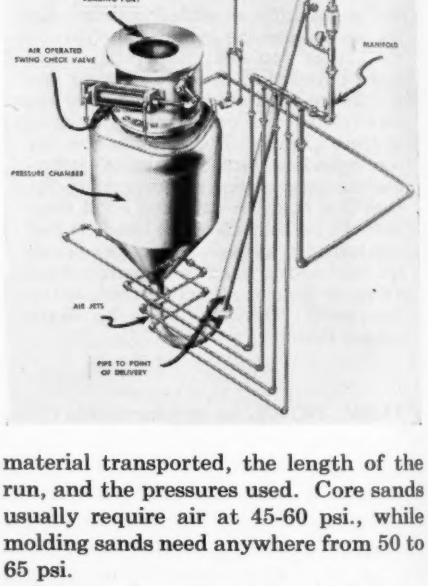
NEARLY two years of operation under actual service conditions has, it is reported, established the practicability of a pipe-line conveyor designed by Crane Company for the transportation of individual batches of sand or other granular, crushed, or pulverized material from receiving stations to storage and from storage to points of application. The system, which is called Turbo-Drive, is operated by compressed air and consists mainly of a pressure chamber with a loading port and of an air manifold.

When the chamber is charged, it is sealed by closing a swing check valve, which is actuated by a pneumatic cylinder. Then it is put under pressure by opening the valve that feeds compressed air into the manifold with five pipe connections, one of which enters the chamber at the top while the four others, provided with jets to agitate the contents, enter at the bottom just above the point where the delivery line is attached. Larger sizes have six jets.

One man operates the entire system and can dispatch batches to as many as fourteen different locations in sequence, or as they may be required, by means of electrically controlled transfer switches. These are interposed in the pipe conveyor, and each is made up of a main-line section, which normally handles the flow, and of a take-off or by-pass section. The latter is shifted into the receiving position by a carriage on which it is mounted and which is moved by an air cylinder that is brought into action by the operator at the Turbo-Drive station. By aid of an indicating device he is informed where material is needed and, when the line is clear, sends a load to that point simply by pressing the control valve of the transfer switch involved.

Crane manufactures valves and fittings and has used two of its Turbo-Drive conveying systems in its own foundries for many months. One handles core sand and transports 900-pound batches at the rate of one every 30-45 seconds with air at 40 psi. The unit is set up in a pit in the basement and carries the material a distance of 90 feet—40 feet vertically and 50 horizontally. The other installation has a pipe line 262 feet long, including a 32-foot vertical section, and delivers Tennessee No. 3 facing-sand addition with a clay content of 16-18 percent in batches of 1200 pounds. It uses air at a pressure of 60 psi.

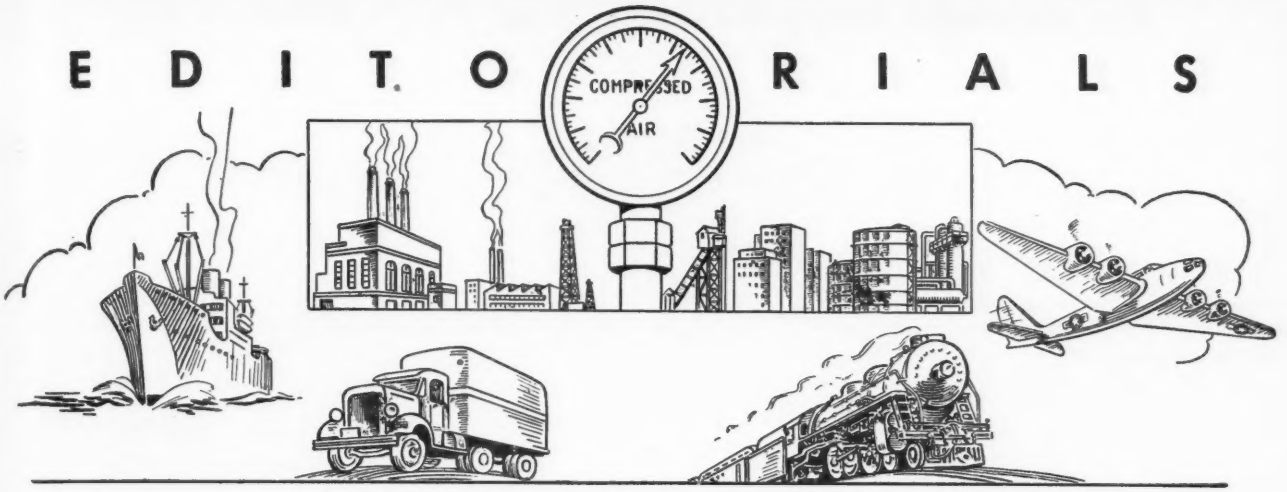
So far the company has designed three units with rated capacities of 7, 15, and 30 cubic feet. Though both smaller and larger ones can be built, these sizes were determined upon because they correspond in cubic content to conventional-type mixers. In the order mentioned, they can handle 500, 1000, and 2000 pounds of sand per minute, or a total of 15, 30, and 60 tons an hour. These are approximate figures and vary with the material transported, the length of the run, and the pressures used. Core sands usually require air at 45-60 psi., while molding sands need anywhere from 50 to 65 psi.



Because the system is completely enclosed, there is no dust nuisance, and the material is protected from loss and contamination in transit. At the discharge end the compressed air enters a special receiving hopper, where it is allowed to expand before escaping to the atmosphere. In the case of very powdery material, the use of a dust collector is advisable.

Experience has shown that core and molding sands do not present an abrasion problem, but that dry sand attacks bends, elbows, and a section of about 18 inches just beyond each bend. Wear-resistant Ni-Hard elbows have been found to stand up fairly well, and in a line delivering between 80-100 tons of dry sand per day they have lasted from two to three months before requiring replacement. Tests with other materials to increase their service life are now in progress.

EDITORIALS



NEW OOMPH FOR CONVERTERS

AFTER conducting close to 3000 tests, the United States Steel Corporation has announced that steelmaking is definitely accelerated when the compressed air used in the Bessemer converter is enriched with oxygen. With that element added, 30 tons of steel can be blown free of impurities in from nine to ten minutes, which is one to two minutes less than when air alone is used. In terms of production, this means an increase of 30 tons of steel from a converter in an 8-hour shift.

An even greater benefit from the steelmaker's viewpoint is that when oxygen is introduced at least five tons of scrap metal can be charged into the converter each blow. This is two tons more than is customary. Because scrap replaces pig iron made in a blast furnace, the latter needs less iron ore, limestone, and coke to supply material for the converter.

Experiments that led to these conclusions were carried on for four months at the works of the National Tube Company, a U.S. Steel subsidiary, in McKeesport, Pa. The steel turned out was used to make pipe, or was charged into open-hearth furnaces for further processing. Its quality was the same as that previously produced, and there was no evidence that the greater heat generated by oxygen enrichment had shortened the service life of converter linings.

It was determined that best results were obtained by adding a volume of oxygen equivalent to about one percent of the air blast, which amounts to from 4000 to 6000 cubic feet of oxygen during each "blow." It was most effective when introduced during the first four minutes of that period of the blow in which carbon is removed from the charge. In that interval it was added at the rate of around 1000 cfm. The final two or three minutes of the blow was completed without oxygen enrichment to avoid over-oxidation of the metal and slag.

The Bessemer or pneumatic process, as it was originally called, was the earliest practical technique of steelmaking discovered and appeared simultaneously in England and America through the independent efforts of Sir Henry Bessemer abroad and William Kelly in this country. It is still the fastest method available for producing steel, and the results of the experiments with oxygen are bound to improve its position in the industry.

At the National Works, the air blast for three converters is furnished by three turboblowers each of which consumes from 25,000 to 30,000 cfm. at 25 to 30 psi. pressure. The oxygen is received in liquid form in tank cars and stored in a tank having a capacity equivalent to 1½ million cubic feet of gas. From there it goes to three units that convert it into gas. The plant can deliver daily about 600,000 cubic feet of oxygen that is 99½ percent pure.

NICKEL'S BIRTHDAY

IT WAS just 200 years ago that nickel was isolated from the ore nicolite by A.F. Cronstedt, a Swedish metallurgist who is also remembered because he introduced the use of the blowpipe in the analysis of minerals. His investigations were prompted by the fact that Saxon miners had for years been baffled by a white metal that they smelted from what appeared to be copper ore. The metal they obtained was not copper, and it was so hard and tough that they could do little with it. Concluding that the devil had cast a spell over their ores, they called the metal "kupfer-nickel," meaning Old Nick's Copper. After five years of experimenting, Cronstedt satisfied himself that the metal had not been previously identified, and he called it nickel.

Although not isolated before, nickel alloyed with other metals had been used since early times. Ancient Orientals apparently learned to fashion implements from the metals of meteorites that fell from the sky. One combination frequently found in these celestial missiles is nickel and iron, and it is believed that the warriors' swords, so renowned for their keeness, were made therefrom. According to tradition, those swords were sent from heaven, and the theory of their meteoritic origin would explain this. Early Chinese artisans fashioned boxes, candlesticks, and other objects from a metal that was called *paktong*. Five years after Cronstedt named nickel, another Swedish scientist, von Engestrom, discovered that *paktong* contained copper, nickel, and zinc. Production of similar alloys was then begun in Europe, and they were known as German silver and nickel silver.

Copper-nickel coins were introduced in Belgium back in the 1860's and pure nickel ones in Switzerland in 1881. More than 100 governments now use nickel in their coinage. Nickel plating was first done commercially in 1870. Until a few decades ago, nickel consumption was confined mainly to the applications mentioned, and mines in Norway and New Caledonia easily met all demands. The huge ore deposits at Sudbury, Canada, which now dominate world output, were discovered by chance in the late 1880's when crews building the Canadian Pacific Railway blasted a line through them. Prospectors swarmed in and mining began in 1886.

Quantity consumption of nickel began when it became known that it would toughen steel. Around 1890 naval authorities became interested in nickel-bearing armor plate. World War I accelerated the use of nickel alloys, and since then industrial applications have grown strikingly. In normal times the automobile industry is the largest consumer. Stainless steel contains 8 percent of nickel, and other alloys from 2 to 90 percent.

One of the world's greatest mining enterprises, The International Nickel Company, is based on the Sudbury deposit, and the Dominion's 1950 production of the white metal approximated 125,000 tons. The vast open-pit operations are gradually giving way to underground workings. Canada's observance of nickel's anniversary includes the minting of a special souvenir coin of pure nickel.

Air Bubbles Keep Sawmill Log Pond Free of Ice

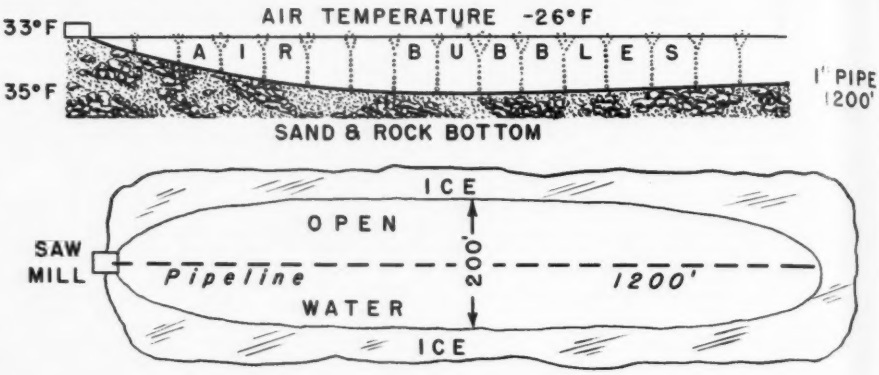
BUBBLES of compressed air give promise of prolonging the working season of lumber plants in northern latitudes. Most of the sawmills across the northern tier of states in this country and throughout Canada have had to close down each winter when ice formed on the ponds used for floating logs to the primary saws. A few have remained open by trucking logs in as needed or by turning steam into the ponds to prevent freezing. Either course is expensive.

Warren Brown, of Brown's Tie & Lumber Company, McCall, Idaho, licked the problem in a very simple way. He bored 1/32-inch holes at intervals of 80 feet in 1-inch pipe and laid 1200 feet of it from the slip, where the logs are taken from the water for sawing, out into and on the bottom of the pond. The outer end was capped and the land end was connected with a 105-cfm. compressor driven by a gasoline engine.

Air was turned on before freezing set in, and as it issued from the perforations bubbles rose to the surface, fanning out in their ascent. When the temperature dropped, ice began to form around the edges of the pond, but none appeared for a considerable distance on either side of the line along which the pipe ran 20 to 110 feet below. Even when the thermometer was around 26 degrees below zero for two weeks, an area 200 feet wide and 1200 feet long remained open, although ice was so thick elsewhere that it could support a team of horses or an automobile. The Brown mill continued to operate throughout the winter and at very small additional cost.

The idea of thwarting the formation of ice with air bubbles is not new, but this is believed to be its first application in the lumbering field. Similar systems have been used for some years at hydroelectric generating plants to relieve ice pressure against dams and to maintain open waterways at intakes and sluice gates. Articles describing such installations have appeared in these pages as far back as 1929. Another account tells how the same principle has been applied to a municipal pond to prevent the formation of ice that endangered the lives of migrating ducks. Strangely enough, knowledge of these installations apparently never reached the logging industry. Thus we find Mr. Brown rediscovering the idea independently and developing it through experimentation.

Our informant, A. Whisnant, secretary of the management committee of the Pacific Logging Congress, Portland, Oreg., writes: "I don't know why someone hasn't discovered this system before in the logging and lumbering industry, for frozen log ponds have been the reason for many winter closures and a tremendous expense to the industry."



LAYOUT OF AIR PIPE

Sectional and plan drawings showing the simple piping arrangement by which compressed air at 100 psi. was introduced into the log pond of Brown's Tie & Lumber Company last winter. The scheme maintained open water even when the temperature of the air remained around 26 degrees below zero for two weeks. At its deepest point the pipe is 110 feet below water level.

According to Mr. Whisnant, ice has always slowed or stopped winter operations of all American and Canadian sawmills except those in the moderate west-coast region or in the South. In some cases, where exhaust steam is not available, extra boilers have been put in to provide steam for warming the water. Even then the results have not been entirely satisfactory because log-storage areas are too expansive to keep them thawed out during extremely cold weather. In Idaho, where the temperature regularly plunges to from 25-40 degrees below zero, thousands of dollars have been spent over the years in attempts to combat ice. None of these efforts was wholly effective until Mr. Brown came up with his scheme.

While Mr. Brown didn't originate the idea he exploited, he did figure out correctly why it works. Although agitation of the water by the ascending air bubbles has some effect, it is not primarily responsible for keeping ice from forming. It has been determined that water reaches its greatest density at a temperature of 39°F. and, consequently, sinks to the bottom. The air bubbles lighten this relatively warm water and bring it to the surface. Colder water replaces it and is, in turn, warmed and lifted by the bubbles. This circulatory movement is repeated over and over, and the surface water never quite reaches the freezing point of 32°F.

Mr. Whisnant suggests that this method might be used on water lanes in northern harbors that are ordinarily ice-bound in winter. He is even optimistic over the possibility of keeping shipping on the Great Lakes in operation in this way during cold weather. So far as is known, no experiments have been carried on to determine the effectiveness of the scheme where the piping would have to be strung at a considerable depth below water level.

New Light in Panel Form

AN INTERESTING departure in the field of illumination that may affect the industry as vitally as did the fluorescent lamp has been announced by Sylvania Electric Products, Inc. The source of light looks like a sheet of frosted glass and does not generate heat like the incandescent bulb or give off a gaseous discharge like the neon tube or the fluorescent lamp. It consists of a plate of electrically conducting glass that has a phosphor-coated insulator on one side and is encased in metal foil only a few thousandths of an inch thick. A simple power connection has been devised, and light is induced by the direct transfer of alternating current to the phosphor.

The new "electroluminescent lamp" is an area rather than a point or line source of illumination and throws a soft, shadowless light that is not too intense to be viewed directly; in fact, is less than that from conventional fixtures. To illuminate a room on 110-volt, 60-cycle current, reports Arthur D. Little, Inc., it would be necessary to cover a whole wall or ceiling with panels. However, brighter light can be obtained by higher voltages and frequencies, which would involve the use of a transformer.

It is unlikely that commercial installations of this type will appear for several years; but for special decorative purposes, where cost is no consideration, the method has much to offer. Initially, we may expect to see the new lamp illuminating small areas including instrument panels, clock faces, and key holes, as well as in the form of night lights, markers for darkrooms, steps, etc., in fact, in any service for which ordinary household current is adequate.

This and That

Competition for the Honeybee

Two inventors in Oroville, Wash., are aiming to deprive the honeybee of its traditional job of carrying pollen from blossom to blossom in fruit orchards. Ira A. Marchant and Edwin P. Johnson have devised a machine that sprays pollen gathered from a selected tree on to the blossoms of other trees. The spraying force is compressed air drawn from a tank or supplied by manually operating a bulb.

★ ★ ★

Air in Largest Reactor

In the March issue of *Think*, Leon G. Davis mentions two applications of compressed air in the operation of America's most powerful atomic reactor—the $25,000,000 unit at Brookhaven National Laboratory, Upton, N. Y., which will be used almost exclusively for peacetime scientific research. To produce radioisotopes for purposes of study, various elements are inserted in a large, multichanneled cube of graphite and bombarded by neutrons released by the fission of uranium 235. Because some radioisotopes decay—lose their radioactivity—in a matter of minutes or even seconds, they must be studied quickly. To facilitate this, pneumatic tubes have been provided to whisk them out of the pile and deliver them to adjacent laboratories in a few seconds.

To carry away the enormous quantity of heat generated in the reactor, 300,000 cfm. of air is drawn through the pile by centrifugal compressors. Each machine is 12 feet in diameter and driven by a 1500-hp. motor. In some of the narrow passageways the air attains a speed of "some hundreds of miles per hour." As the air flows through the reactor, one of its constituent gases, argon, becomes radioactive but retains the radioactivity only a short time. To guard against contamination, the air goes up a 320-foot stack before it is exhausted. Because dust particles also might become radioactive, the air is filtered both before and after it passes through the reactor.

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Mine Grows Timbers

Bunker Hill & Sullivan Mining & Concentrating Company, which operates in the Coeur d'Alene district of Idaho, is preparing to grow its own mine timbers. It will plant from 25,000 to 50,000 trees annually on a 19,000-acre tract set aside for the purpose. The company uses between six and ten million feet of lumber a year mostly for underground supports, chutes, etc. The plan to grow its own is in accordance with a reforestation program sponsored by the Western Pine Association.

★ ★ ★

Hollinger's Underground Mine Shop

The Hollinger gold mine at Timmins, Ont., Canada, has a new machine shop 1100 feet underground. It replaces a smaller shop on the same level that was used for 25 years. To provide a room 100 feet long, 35 feet wide, and 8½ feet high, it was necessary to drill, blast, and remove 2069 tons of rock. A level concrete floor was poured and steel beams set to support the roof.

The shop is intended primarily for servicing rock drills, slusher hoists, mucking machines, and hose, and a crew of thirteen operates it two shifts a day. A $50,000 stock of repair parts is carried. After a drill has been repaired, it is tested in a nearby heading before being sent back into the mine, and if it does not perform satisfactorily it is rechecked. Newly purchased drills are similarly tested. The shop keeps a record of each machine, as well as of the miners who use it and the supervisor responsible for its care. Over an extended period these records show which drills stand up best and also give an idea as to when they may have to be replaced.

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Novel Angling Contest

Men who fish for sport prefer mild weather, but they'll go out just about anytime there's a chance to catch something. Proof of this was given on March 11 when more than 250 employees of the Hollinger Mine and members

"Surely, Comrade, the voice of Utopia can be heard above the common sounds of American free enterprise."

of their families participated in the fourth annual fish derby. They drove 30 miles from Timmins, Ont., Canada, over snow-covered roads to Kenogamissi Lake, chopped holes through several feet of ice, and set up their rigs. The contest closed at 4 o'clock in the afternoon, by which time more than 100 fish had been hauled in. The winning catch was a 15-pound, 10-ounce pike, with second place going to a 9½ pounder.

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Shaft Sinking Record

Americans excel as tunnel drivers, but South Africans are easily the fastest shaft sinkers. From the Transvaal gold-mining capital of Johannesburg comes word of two new records established successively in March and April of this year in the Virginia No. 3 Shaft. In 30 days in March (work was suspended on Good Friday) the crews sank 470 feet, but in April they made an even higher record—504 feet. These marks take on additional importance when it is realized that the shaft is 24 feet in diameter (circular in section) and that the footages include both excavating and concreting.

The previous record was a total of 461 feet made at the Van Dyk Mine in August, 1941. But this shaft is only 16 feet in diameter and was not lined. The nearest approach for a lined shaft of comparable diameter (23½ feet) was 386 feet established in August, 1926, at the Randfontein Estates Mine. The best monthly progress in a rectangular shaft was 454 feet at the West Rand Consolidated property in May, 1940. As an indication of how shaft-sinking has been speeded up in a quarter of a century we refer to our December, 1928, issue in which we reported the setting of a new record in No. 4 Shaft of Spring Mines, Ltd., of 1174 feet in four months. That was an average of 287 feet a month, and the best monthly mark was 300 feet.

At the Merriespruit No. 1 Shaft, which is near the Virginia and of the same size, an improved shaft-sinking method was inaugurated recently, and in January of this year a total of 351 feet was attained. It is being followed at the Virginia, and the new records are attributed to the cumulative experience gained with that technique. Its principal feature is the employment of a 2-tier Galloway stage that permits lining to proceed while drilling is being carried on at the shaft bottom, halts being required only when shots are fired. The arrangements are such that concrete is lowered from two mixing plants while rock is being hoisted. In the case of the April record it was necessary to drill, break, and hoist approximately 22,500 tons of rock and to mix, lower, and place about 1760 cubic yards (2150 tons) of concrete. The crews are thoroughly capable men, and a high degree of teamwork has been developed. A departure from the usual practice is the use of four complete crews. Each group works eight hours and rests 24, instead of the usual sixteen. The extra time off is reported to make a noticeable difference in efficiency.

Big Aluminum Casting Poured in Permanent Mold

WITH the production of a 500-pound aluminum casting in a permanent instead of a sand mold, the John Harsch Bronze & Foundry Company of Cleveland, Ohio, has, according to the industry, made a great stride forward in the art. The customary method was discarded when it was found that the operation would be both slow and costly and that four bays would have to be given over to it.

The substitute mold is 65 inches high, has an average diameter of 46 inches, weighs nearly 10 tons, and is built of meehanite. It is in sections, that are hinged and mounted on rollers to facilitate closing and opening, and is surrounded by rows of gas burners to keep it at the temperature that will insure the best pouring conditions.

As a result of the changeover, the work is now confined to one bay, and a group of four men can make twelve instead of four units a day. In addition, the permanent-mold casting is characterized by high strength and has a smooth surface that is easy to machine.

HUGE BUBBLE FOR RADAR INSTRUMENTS

Resembling one end of a giant watermelon, this dome of specially compounded rubber and fiber glass houses radar equipment that detects the approach of enemy aircraft. When inflated with air at less than 1 pound pressure, it stands 37 feet high and is 54 feet across. The walls protect the delicate instruments from dust, but are thin enough to permit clear reception of the radar signals without distortion. The radar-dome, as it is called, was built by The B. F. Goodrich Company for the United States Air Forces.

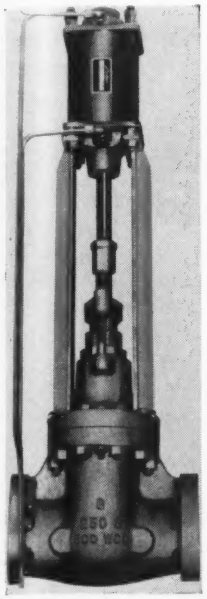
Electronic Reader

MUCH of the tedious work involved in recording data for computation from strain, pressure, acceleration, and temperature gauges, pilot plants, and other physical and control instruments used in some fields of research may be eliminated by a new electronic device developed by Arthur D. Little, Inc. Originally designed to obtain and convert data on infrared spectra, the potential value of the Digital Reader was immediately recognized, and now the company is building units that are easily incorporated in a variety of multiple-instrument reading and recording systems.

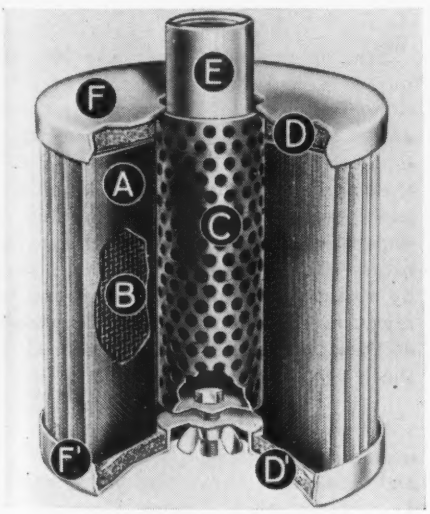
By present methods it is often necessary to photograph instrument dials at stated intervals, and research workers must then jot down the readings in numerical form and arrange them for computation. Charts traced by recording devices must be similarly examined and translated with care. The Digital Reader receives electrical signals from recording instruments and converts them directly into convenient binary-digital form for immediate analysis, computation, smoothing, or storage on recording media. The new units will be about 20x 30x5 inches in size and will operate on 110-125 volt current. It is claimed that they will take readings at the rate of 50,000 per second and record them on tape or punch cards for computation.

Industrial Notes

Actuators that can be adapted for any make, size, and type of valve and to operate against any line pressure have recently been introduced by the Ledeen Manufacturing Company. They are essentially cylinders of varying sizes powered by steam, water, oil, or compressed air at pressures ranging from 15 to 750 psi. and are provided with valves, controls, brackets, and couplings for attachment in the factory or by the user to dampers, sluice gates, and gate, plug, diaphragm, and butterfly valves. Ledeen Actuators are equipped for on-and-off or for positioning service and with varying types of controls for both direct and remote valve operation.



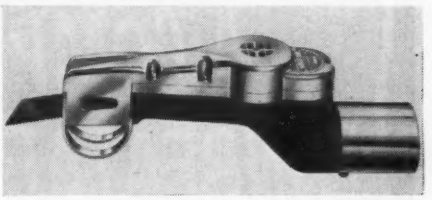
Shown in the accompanying illustration is a cut-away view of a Staynew hydraulic filter recently introduced by Dollinger Corporation. It is designed for use in connection with lathes, mills, shapers, planers, drills, and many other types of cutting tools where dirty liquids are collected and recirculated. There are eight models with an active filtering area ranging from 1 to 14.3 square feet and a capacity of 5 to 72 gpm. based on clean 100 SSU oil at 100°F. and 100-mesh media. The latter vary with service conditions and include inserts made of fabrics and metals of different kinds. Use of the filters is said to insure clean liquids free from abrasive particles that are harmful to pumps and machinery and are responsible for spoilage and rejects.



RADIAL-FIN CONSTRUCTION
This unit has a 100-mesh insert of stainless-steel wire and is suitable for filtering cutting and quenching oils. It has a capacity of 7 gpm. A, insert; B, coarse-screen backing; C, perforated supporting tube; D, D¹, thick felt gaskets; E, threaded outlet sleeve; F, F¹, upper and lower end plates.

New York State is trying out something new in traffic-line markers. Instead of paint, which wears off quickly, it is putting stripes of white plastic on 3.36 miles of highway at a cost of $4900. The material, which is of the thermoplastic type, comes in strips 4 inches wide and from 60 to 72 inches long and is laid at a temperature of about 425°F. in dry, clean grooves approximately ½ inch deep. The job is completed by passing a hot roller over the marker to level the surface and cause the plastic to flow and fill any openings. The work is being done by Traffic Lines, Inc., of New York City.

Packed in a kit complete with a wide assortment of blades, R.C.S. Tool Sales Corporation's new power Super Saw is said to cut anything from Ebonite, Transite, Inselbrick, and wood to metal, including wire, nails, and pipe. It may be operated by any standard ¼- or 5/16-inch air or electric drill or flexible shaft, and is controlled by fingertip. (In the case of an air drill the required pressure is 100 to 125 psi.) A built-in blower keeps it cool, and chips and sawdust are blown from the cutting line by the exhaust air, which is directed forward towards the blade. Elements subjected to wear are interchangeable and are oiled in one application by a special nonfluid lubricant that comes in a tube which is screwed into a grease fitting on the underside of the casing. The tool cuts angles, curves, and circles as readily as straight lines, it is claimed, and its long slim lines permit working in normally inaccessible places. No starting hole is required. The saw is held tight against the material, using a

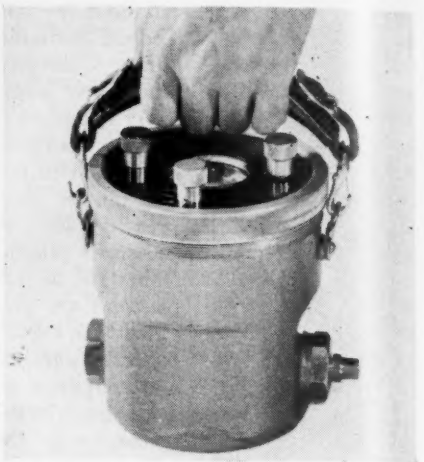


guide on the underside as a fulcrum. When it is set in motion, the tip of the blade is brought in contact with the work and the tool is gradually raised from a slanting to an upright position. The Super Saw, exclusive of the driver, is 10¾ inches long and weighs 3 pounds 6 ounces.

Rubber and metal are being bonded by a new method that eliminates brass plating, according to the National Rubber Bureau. Known as the Redux Process, it involves treating the rubber surface with sulphuric acid; washing, drying, and applying a resin to the rubber and the metal; and uniting the two under moderate temperature and pressure.

For the first time, it is claimed, there is now available an explosion-proof indicator for flammable gases for use in Class 1, Group D hazardous locations. A product of The Lor-Ann Instrument Company, Inc., it embodies a Wheat-

stone bridge and two small platinum coils, one to compensate for temperature changes and battery drift and the other to detect the presence of such gases. The measuring coil or element is heated electrically to incandescence, and when a



flammable gas comes in contact with it combustion results, causing a proportional change in resistance. This is transmitted to a meter that indicates the air-vapor ratio. The instrument is easy to use and carry because it weighs only 6 pounds and, in addition to the "on" and "off" switch, needs only two controls—a voltage-check knob and a zero-setting knob.

Nearly all gold ores in the Union of South Africa contain small percentages of uranium compounds, and these are to be recovered in four plants now being planned. All the ore mined, as well as the tailings that have accumulated through the years are to be treated there and the entire output is to be sold to Great Britain and the United States.

Strange products are made for test purposes, and among these is perspiration. It is obtained from acids and salts and is used in the laboratory to determine the effectiveness of slushing oils that serve to protect finely machined parts against corrosion attributable to fingerprints. Although insignificant as to quantity, the moisture left on a part by a single print may cause rust and its rejection. Between 40- to 50,000 barrels of these special oils were consumed in the United States last year.

Where quantities of dynamite are required on construction jobs, its handling and safe storage have always presented a problem that Dravo Corporation seems to have licked. That company has produced what it calls the Transportainer, a welded steel container with a capacity of 6 tons in which the explosive can be shipped and stored in the open. Danger of sparks incident to tools, shoe nails, etc., in contact with the inner walls is offset by a lining 1 inch

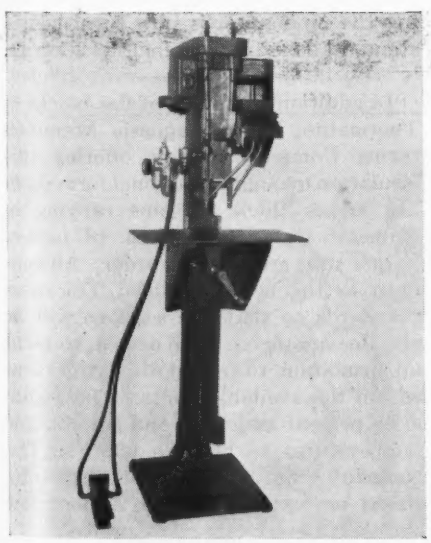
thick. Two of the 275-square-foot boxes are being used by Hunkin-Conkey Construction Company on its Pennsylvania Turnpike extension contract.

It is reported that aluminum foil about 0.001-inch thick is being used successfully by a group of surgeons in Toronto, Canada, for dressing burns.

Standard-size concrete building blocks with a ½-inch bevel on the outer face to give the effect of clapboard have been put on the market by the Zonolite Company of Chicago, Ill. Known as Burkard blocks, they are composed of two shells of solid concrete tied together by steel rods and are of tongue-and-groove construction to insure correct alignment.

Glass is being soldered to metal by a process that is said to produce a bond stronger than the glass itself. The parts to be united are coated with a thin film of titanium hydride. Then the solder is applied and the assembly is heated to approximately 900°F. under a vacuum. The technique was developed by General Electric Company, and is also being used to bond ceramics and carbon to metal.

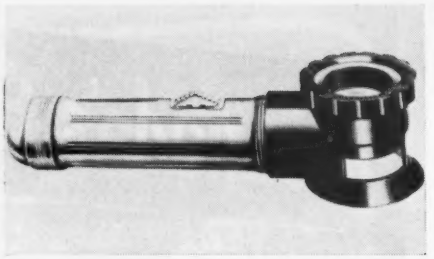
In addition to its single-spindle power screw-driving machine of the Reynolds type, Cook & Chick Company now has patents pending on multiple-spindle units that permit driving up to four screws at a time, thus eliminating relocating the assembly and repetitive operations. The screws are supplied by an oscillating hopper with a special self-clearing gate to insure steady feed to the



high-speed spindles, which are equipped with an accurate torque control and with a disengaging clutch for smooth driving action. The screws are firmly supported and aligned with the work by jamproof locating chucks. All the machines are foot controlled and operated with compressed air at from 20 to 80 psi.,

depending upon service needs. According to the company, both customers and operators prefer this power medium because it increases production and lessens fatigue. The unit illustrated is of the 2-spindle type.

Flash-O-Lens, a precision instrument suitable for inspecting work where close attention to fine details is essential, is available in an improved form. Made by Abbeon Supply Company, it combines a magnifying glass with a powerful light that illuminates the magnified field of vision without throwing direct rays into the user's eyes. The improved



model features a new Bausch & Lomb lens system that gives a clearer, flatter field of vision and lessens distortion and aberration. For greater strength, the lens system is housed in Bakelite and the case is made of chrome-finished steel. The instrument uses the same kind of dry batteries as the standard 2-cell flashlight. It is obtainable for 5-, 7-, 20-, and 40-power magnification.

Texas has a pipe line that is unusual because it wears an overcoat to keep it warm. The line extends from a new oil well to a gathering system and carries extremely viscous crude oil. Of 2-inch diameter, it is encased in a magnesium-insulated 4-inch pipe through which hot water is circulated.

For instant control of all types of equipment powered by air, oil, or water under pressure, as well as for process-machine applications, Airmatic Valve, Inc., has developed a new solenoid, 2-way shut-off valve known as Model LDS-2-750. It is constructed throughout of cast naval bronze and features a positive seal, ports in line, and only one moving part. Designed for a pressure range of 0-255 psi. it operates on direct or alternating current. The valve, according to the manufacturer, has eliminated the use of levers, pilots, and other forms of indirect application, lessens the possibility of foreign matter accumulating on the seat, and permits inspection and servicing without disturbing the piping. It is now furnished in standard sizes from ¼ inch to 2 inches.

In addition to its line of flat blocks of Thermalite, Ehret Magnesia Manufacturing Company is now offering this insulation in molded sectional form up to 2½ inches thick for pipe ranging in diameter from ¼ inch to 18 inches. Larger sizes are made to order. All conform to the new Simplified Thickness Standards so that the sections will fit into one another, can be nested, to build up insulation to any desired thickness within the available limits. Thermalite is 85 percent magnesia and suitable for temperatures as high as 600°F. The company claims that it is not affected by steam or water and that it does not shrink or deteriorate structurally.

Use of Hydrolift after metal surfaces have been rinsed with water obviates the work of drying, says the London Chemical Company. The preparation is applied by cold dipping, brush, or air spray and forms a molecular film that brings the moisture to the surface, where it runs off. It is claimed that the coating

OLD GLOVES MADE NEW

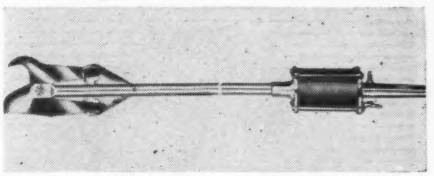
Roughly, four-fifths of the work gloves that are discarded as worn out can be reconditioned for further service, according to the U.S. Industrial Glove Corporation, of Detroit, Mich. Either leather or fabric gloves may be restored, it is reported, and workers often prefer them to new ones because of their greater pliability and comfort. The before-and-after picture is self-explanatory.

dries thoroughly in fifteen minutes, a state in which it cannot be seen or felt, and that it leaves a clean surface for plating or other finishing. It can also be used to protect metal during short-time storage between operations. A gallon covers 8200 square feet.

Carboloy Company is making a new metal that is said to be 50 per cent denser than lead. It is called Hevimet and is suitable for such parts as gyroscopes, balance weights on crankshafts, variable-pitch propellers, etc., as well as screens resistant to radioactive rays.

Construction is soon to be started by the Pittsburgh Consolidated Coal Company on a pipe line to demonstrate the practicability of transporting coal in slurry form. It is an outgrowth of a pilot system and will consist of a 12-inch pipe extending for a distance of 17,000 feet from the Georgetown strip operation of the Hanna Coal Division near Cadiz, Ohio. After being washed, crushed to fine size, and mixed with water, the coal will be moved through the line by pumps designed for the purpose. Drying equipment will be set up at the discharge end to dewater the slurry and to prepare the coal for use. The system is to be provided with instruments to permit the recording of all essential engineering data.

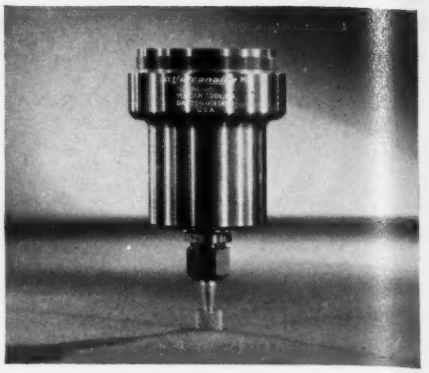
Specialists in pruning equipment since 1860, the J. T. Henry Manufacturing Company has developed a power shear that not only expedites the work of brush and line clearance and grubbing but also reduces operator fatigue to a minimum. The No. 500 Silver Giant, as it is designated, is operated with air at 125 psi. pressure and trims trees with jaws of tempered steel at the rate of 25 strokes a minute, cutting a 2-inch hardwood



"It's like I told you Boss, the L-shaped compressor is the maintenance man's dream!"

branch clean with one trigger-action stroke. Slim-lined, the tool is made of aluminum alloy but is furnished with shafting of insulated fiber glass for operations near electric lines. The shear is available in lengths from 3 to 10 feet and is said to have increased production over manual methods anywhere from 300 to 400 percent.

Following many tests and applications in customers' plants, Vulcan Tool Company is now engaged in the manufacture of a new precision spindle for production or toolroom operations where extreme accuracy must be maintained. Called Vulcanaire, it is only 3 5/16 inches long and is powered with the same type of air-cooled high-speed air motor that has proved its worth on the company's jig grinder. All parts of the spindle are made of alloy steel machined and ground with



care to insure perfect balance. The Vulcanaire is suitable for use with most standard and production machine tools such as internal and surface grinders, vertical or horizontal mills, gear shapers, wood-routing machines, radial drills, pantograph engraving machines, lathes, etc.

Industrial Literature

A 4-page bulletin (No. 00345) on heat-transfer equipment for diverse industrial purposes is offered by Modine Manufacturing Company, Racine, Wis.

Hose clamps, tools, and fittings are the subjects of a 12-page catalogue obtainable from the Punch-Lok Company, 321 North Justine Street, Chicago 7, Ill.

Small-size Terry turbines, used by industry for more than 50 years, are described in detail in a 6-page bulletin distributed by The Terry Steam Turbine Company, Hartford 1, Conn.

Equipment and methods for maintaining tar-and-gravel roofs are discussed in a bulletin issued by The Tremco Manufacturing Company, 8701 Kinsman Road, Cleveland, Ohio.

A booklet of technical papers dealing with the lubricating properties and capacities of molybdenum disulphide has been produced by Climax Molybdenum Company, 500 Fifth Avenue, New York, N.Y.

Safety heads for use on various types of pressure equipment are covered in detail in a 52-page catalogue made available by Black, Sivalls & Bryson, Inc., 7500 East 12th Street, Kansas City 3, Mo.

Wheelco Instruments Company, 847 West Harrison Street, Chicago 7, Ill., offers Bulletin MPC-1 which describes its Capacilog, a strip-chart recorder that makes up to six permanent records on one chart.

Complete statistics on automobile-accident deaths and injuries in 1950 are given in a booklet, R.I.P., obtainable from The Travelers Insurance Companies, Hartford, Conn.

A 4-page folder issued by A.L. Smith Iron Company, Chelsea 50, Mass., tells of the concern's facilities and qualifications for fabricating metal and assembling electrical components.

Pointers on the care and maintenance of power-driven belts to increase their service life are presented in concise form on a poster chart offered by Cling-Surface Company, 1032 Niagara Street, Buffalo 13, N.Y.

The hydrogen Zeolite water-softening process, which was introduced in 1935 to supplement the much earlier sodium Zeolite process, is explained and discussed in a bulletin issued by Cochrane Corporation, Philadelphia 32, Pa.

Concrete reinforced with bamboo instead of steel is discussed in the March, 1951, issue of *Technical Reports Newsletter* available upon request from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

Viscorator instruments for the continuous measurement and control of viscosity of fluids used in industrial processes are described in Catalogue 88, obtainable from Fischer & Porter Company, 4030 County Line Road, Hatboro, Pa.

A quick-drying enamel finish paint that adheres well to metal, wood, or concrete without the necessity of applying a prime coat is described in Bulletin 239, issued by the manufacturer, The U.S. Stoneware Company, Akron 9, Ohio.

A general catalogue dealing with blocks and sheaves for use with wire rope can be obtained from American Hoist & Derrick Company, St. Paul 1, Minn. It includes a section with information on how to figure line parts.

Plastic caps to cover Alemite lubrication fittings and prevent dirt from entering them are described in Bulletin P-5103 obtainable from the Plastics Division, The S.S. White Dental Mfg. Company, 10 East 40th Street, New York 16, N.Y.

The vapor degreasing method of cleaning metal parts is described and illustrated in a question-and-answer booklet being distributed by Phillips Manufacturing Company, 3475 W. Touhy Avenue, Chicago, Ill. It is called the *Vapor Degreasing Handbook*.

Superex block insulation for furnaces and other types of heating equipment is described in a 4-page folder by its manufac-

turer, Johns-Manville, 22 E. 40th Street, New York 16, N.Y. This material is reportedly used on 90 percent of the country's hot-blast stoves.

Bulletin GEA-5469 covers a new General Electric hook-on power-factor meter for use in industrial plants where maintenance of high power factor is an important economic consideration. It may be obtained by writing the company at Schenectady 5, N. Y.

A complete line of creams and liquids for cleaning and protecting the hands of factory workers is produced under the trade name Skin-Cote by The Boyer Campbell Company, 6540 St. Antoine Street, Detroit 2, Mich. A 16-page descriptive catalogue will be mailed upon request.

Many standard optical parts can be incorporated in various types of instruments to avoid the higher cost of making them up specially, according to Bausch & Lomb Optical Company, Rochester 2, N.Y. With that in mind the concern has issued a new catalogue, No. L-117, titled *Optical Parts*.

It is reported that few job foundries are equipped to turn out round castings for wheels, pulleys, rolls, etc. The Pyott Foundry & Machine Company, 328 North Sangamon Street, Chicago 7, Ill., specializes in work of this type and has described its facilities in a folder that is available upon request.

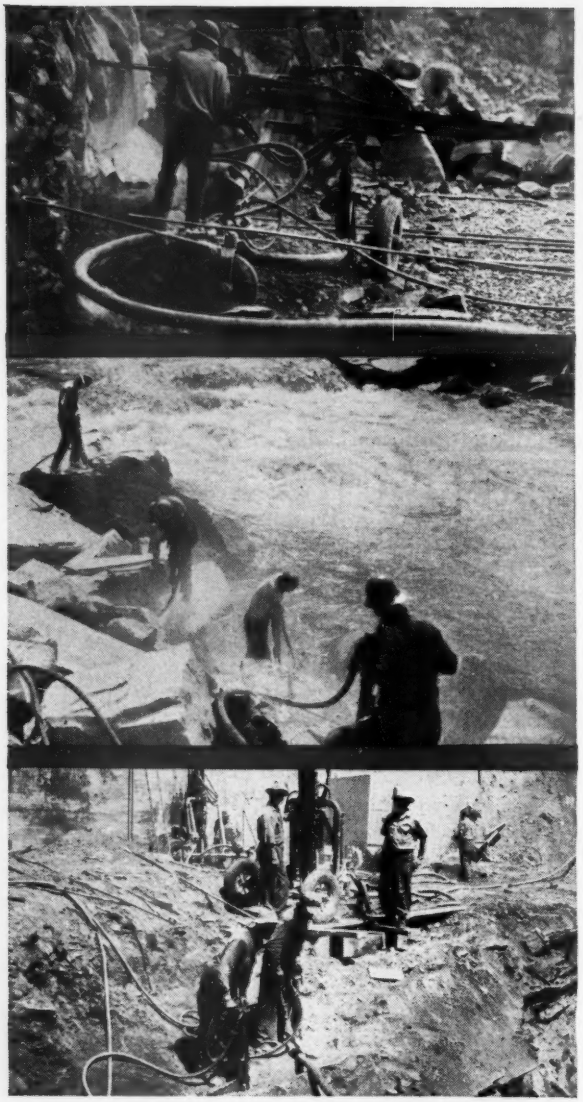
Film-type heat exchangers manufactured by Henry Vogt Machine Company operate in a vertical position and will give good results, it is claimed, even where dirty water must be used. The coolers are described and illustrated in a new bulletin, No. HE-7, obtainable from the company, 10th and Ormsby Streets, Louisville 10, Ky.

A good idea of the important part played by organized research in a defense economy can be gained from the 1950 annual report of Stanford Research Institute. The 36-page booklet reviews the varied activities of what is termed the "applied research center for the West." Copies may be had by addressing the Institute, at Stanford, Calif.

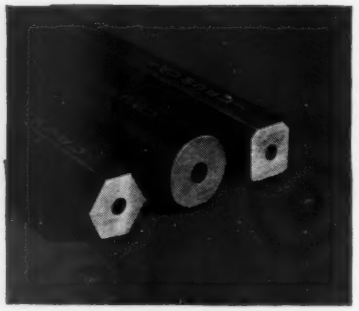
Half a million copies of an inspirational booklet, *Seeds of Victory*, have been prepared by Caterpillar Tractor Company, Peoria, Ill., for distribution to its employees, suppliers, stockholders, and others who request it. Its purpose is to show the importance of producing the sinews of war, and it illustrates how the company's products can contribute towards that end.

Those concerned with roof maintenance will find most questions that may arise answered in a 32-page brochure, *Solving Roof Problems*, prepared by Tremco Manufacturing Company, 8701 Kinsman Road, Cleveland, Ohio. It discusses the construction of various kinds of roofs, the factors that enter into their deterioration, and how the troubles can be diagnosed and treated.

An increasing trend towards the use of power-operated valves in the petroleum, gas, chemical, and process fields is pointed out by Rockwell Engineering Company, which is distributing a 44-page manual describing its line of Nordstrom valves of this type. The publication, which includes 4-color illustrations of valve installations, is called the first complete compilation of technical data covering the use of pneumatic, hydraulic, and electric operators for lubricated plug valves. The booklet, identified as Bulletin V-214, can be had by writing the company at 400 North Lexington Avenue, Pittsburgh 8, Pa.



when the going's tough—



USE CRUCIBLE HOLLOW DRILL STEEL

The long life of Crucible Hollow Drill Steel . . . even under the severest drilling conditions, is the reason why you get lower cost per foot drilled when you use this high quality drill steel. This is no idle claim! Controlled hardenability, perfection of stress-bearing surfaces and uniform processing all contribute to your assurance of maximum performance.

But even more! Every lot of Crucible Hollow Drill Steel is pre-tested for the harder, faster blows of modern drills. Cut down on costly job delay, and get the most out of your drilling equipment . . . specify Crucible Hollow Drill Steel.

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